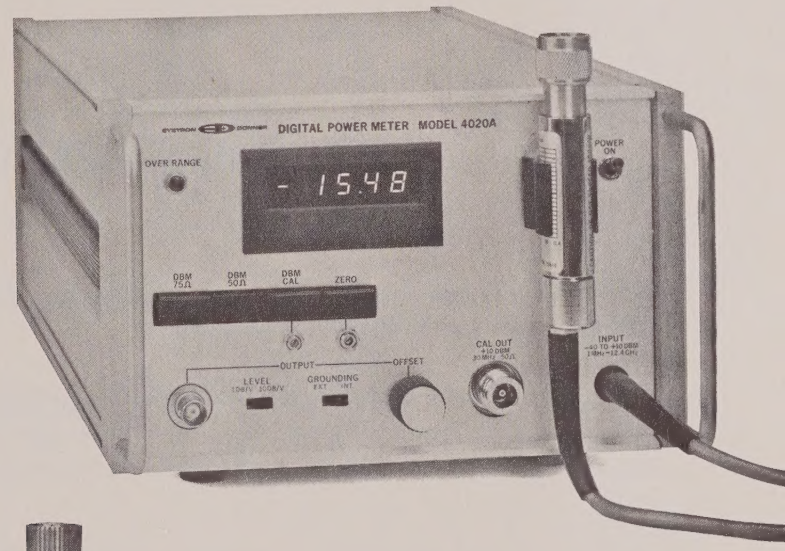
SYSTRON DONNER

OPERATION AND SERVICE MANUAL



MODEL 4020A
(1 MHz TO 12.4 GHz)

MODEL 4021
(10 MHz TO 18.0 GHz)

DIGITAL RF POWER METER

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SYSTRON DONNER CORPORATION
ONE SYSTRON DRIVE
CONCORD, CALIFORNIA 94518 USA

MICROWAVE DIVISION
SYSTRON DONNER CORPORATION
INSTRUMENT GROUP

PRINTED October 1, 1976
MANUAL P/N 950782

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The liability of Seller under this warranty is limited, at Seller's option, solely to repair, replacement with equivalent Systron-Donner equipment, or an appropriate credit adjustment not to exceed the original equipment sales price, of equipment returned to the Seller provided that:

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Richard F. Hall
General Manager

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- ☐ Fair
- ☐ Poor

DELIVERY
- ☐ Early
- ☐ On Time
- ☐ Late

INSTRUMENT PERFORMANCE
- ☐ As Expected
- ☐ Good
- ☐ Defective

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SECTION I

GENERAL INFORMATION

1-1. SCOPE

This manual provides application information, operating instructions, circuit descriptions, maintenance instructions, calibration procedures, replacement parts lists, and circuit diagrams for the Systron-Donner (Microwave Division) Model 4020A and Model 4021 Digital RF Power Meters. This manual also describes certain accessories which are available to increase the usefulness of the power meters.

1-2. DESCRIPTION OF EQUIPMENT

Models 4020A and 4021 are four-digit direct-reading RF power meters capable of measurement over a wide dynamic range without range switching. Both models cover a frequency spectrum from MF through HF, VHF, and UHF to mid-SHF (1 MHz to 12.4 GHz or 10 MHz to 18 GHz). This frequency range corresponds to the JCS bands A through J (radar bands through Ku).

An internal precision calibrator provides a stable 10 mW sine wave signal; the power meter may be calibrated to assure accuracy of all measurements. A calibration chart on the body of the power meter probe lists efficiency correction factors at 2000 MHz calibration points.

The power meter is completely solid-state and features an integrated light-emitting diode display for high brightness and long life. Silicon semiconductors, precision wirewound and metal film resistors, and high-quality glass epoxy circuit boards are used. High reliability is assured through conservative design, careful workmanship, and stringent testing.

1-3. CAPABILITIES AND PERFORMANCE

Both models measure power from -40 to +10 dBm (0.1 μW to 10 mW) in a 50 Ω system; with appropriate adapters, they will measure power directly (no conversion charts or factors) in a 75 Ω system. In addition, both models have a calibrated output signal which can be used to drive an external oscilloscope, voltmeter, or recorder. This is much more than a convenience feature, because it eliminates problems often encountered when more than one function is to be monitored at a single point. When the 4020A or 4021 is used, there is only one 50 Ω termination and only one detector used to measure power and swept frequency response. Finally, the solid-state detector of the power meter is not part of an audio-frequency balanced bridge as is the detector element of most other power meters, and so does not feed audio back into the source or into other measuring devices, or upset the leveling circuits of sweepers or other ALC circuits.

1-4. APPLICATIONS

The Systron-Donner Model 4020A Digital Power Meter has been designed to measure the level of continuous wave (CW), frequency-modulated (FM), or swept RF signals between 1 MHz and 12.4 GHz. Model 4021 measures the levels of these signals from 10 MHz to 18 GHz. Measurement accuracy is best when harmonic distortion or amplitude modulation (AM) of the signal are minimum.

Table 1-1. Performance Specifications

ITEM	PARAMETER	SPECIFICATION	
		4020A	4021
1	Frequency Range	1 MHz to 12.4 GHz	10 MHz to 18 GHz
2	Power Measurement		
2.1	Range, dB	-40 to +10 dBm (0 dBm = 1 mW)	-40 to +10 dBm (0 dBm = 1 mW)
2.2	Range, W	0.1 μW to 10 mW	0.1 μW to 10 mW
2.3	Absolute Maximum Power	+20 dB (100 mW) CW or Peak	+17 dBm (50 mW) CW or Peak
3	Input Impedance	50 Ω (75 Ω w/adapter)	50 Ω (75 Ω w/adapter)
4	Connector Type	Precision Type N Male	Precision sexless 7-mm APC-7
5	Accuracy Error	±1.5% at calibrating frequency (limited by calibrator; better w/external precision power standard)	±1.5% at calibrating frequency (limited by calibrator; better w/external precision power standard)
6	Flatness Error		
6.1	1 MHz to 12.4 GHz	≤±1.0 dB	
6.1.1	1 MHz to 4.0 GHz	≤±0.2 dB	
6.1.2	4.0 GHz to 8.0 GHz	≤±0.4 dB	
6.1.3	8.0 GHz to 12.4 GHz	≤±0.6 dB	
6.2	10 MHz to 18.0 GHz		≤±1.0 dB
6.2.1	10 MHz to 4.5 GHz		≤±0.25 dB
6.2.2	4.5 GHz to 7.0 GHz		≤±0.5 dB
6.2.3	7.0 GHz to 12.4 GHz		≤±0.75 dB
6.2.4	12.4 GHz to 18.0 GHz		≤±1.0 dB
7	Frequency Correction		
7.1	Data Points	7	10
7.2	Uncertainty at 1 mW (0 dBm)	≤2%	≤2% to 12.4 GHz ≤3.5% to 18 GHz

Table 1-1. Performance Specifications (Continued)

ITEM	PARAMETER	SPECIFICATION	
		4020A	4021
8	VSWR		
8.1	10 MHz to 4.0 GHz	≤1.15:1 (≥23 dB return loss)	
8.2	4.0 GHz to 8.0 GHz	≤1.22:1 (≥20 dB return loss)	
8.3	8.0 GHz to 12.4 GHz	≤1.35:1 (≥16.5 dB return loss)	
8.4	10 MHz to 4.5 GHz		≤1.22:1 (≥20 dB return loss)
8.5	4.5 GHz to 7.0 GHz		≤1.35:1 (≥16.5 dB return loss)
8.6	7.0 GHz to 12.4 GHz		≤1.50:1 (≥14 dB return loss)
8.7	12.4 GHz to 18.0 GHz		≤1.60:1 (≥12.8 dB return loss)
9	Linearity Error		
9.1	-40 to 0 dBm	≤±.04 dB	≤±.04 dB
9.2	0 to +10 dBm	≤±.04 dB	≤±.01 dB
9.3	Overall	≤±0.2 dB	≤±0.26 dB
10	Thermal Drift	≤10 nW/°C	≤10 nW/°C
11	Warmup Time to specified accuracies @ 25°C ambient	< 30 minutes	< 30 minutes
12	Calibrator		
12.1	Frequency	30 MHz	30 MHz
12.2	Level	+10 dBm (10 mW)	+10 dBm (10 mW)
12.3	Accuracy Error	≤±1.5% (.065 dB)	≤±1.5% (.065 dB)
12.4	Connector	Type N Female	Type APC-7
12.5	Impedance	50 Ω	50 Ω
13	Display		
13.1	Type	4-digit LED, plus polarity indicator	4-digit LED, plus polarity indicator
13.2	Resolution	.01 dB	.01 dB
13.3	Display Rate	Display refreshed 7 times/second	Display refreshed 7 times/second

Table 1-1. Performance Specifications (Continued)

ITEM	PARAMETER	SPECIFICATIONS	
		4020A	4021
14	Output		
14.1	Level	1 dB/V or 10 dB/V; ±5 V maximum	1 dB/V or 10 dB/V; ±5 V maximum
14.2	Connector	BNC Female	BNC Female
14.3	Impedance	<1 Ω	<1 Ω
14.4	Offset	±50 dB (10 dB/V range) referred to DC output	±50 dB (10 dB/V range) referred to DC output
15	Output Response Time		
15.1	-10 to 0 dBm Ω 10 dB/V	200 μs	200 μs
15.2	-30 to +10 dBm @ 10 dB/V	1 ms	1 ms
15.3	-10 to 0 dBm @ 1 dB/V	2 ms	2 ms
15.4	-30 to +10 dBm @ 1 dB/V	10 ms	10 ms
16	Power		
16.1	Voltage	115 or 230 V ±10%	115 or 230 V ±10%
16.2	Frequency	50 - 400 Hz	50 - 400 Hz
17	Temperature		
17.1	Storage	0° to +55°C	0° to +55°C
17.2	Operating	+18° to +45°C	+18° to +45°C
18	Physical		
18.1	Type	Half-rack size	Half-rack size
18.2	Dimensions	5-1/4" H x 8-1/2" W x 13" D	5-1/4" H x 8-1/2" W x 13" D
18.3	Weight	8 lbs maximum	8 lbs maximum

SECTION II

INSTALLATION

2-1. UNPACKING AND INSPECTION

2-1.1 The instrument is shipped in a specially constructed container to provide maximum protection to the equipment during transit. Use care when unpacking to prevent damage to equipment, such as cabinet finish, controls, indicators, connectors, etc.

2-1.2 Removing Contents

To remove the instrument from the shipping container, cut and fold back outer carton top flaps, remove top protective cushion, lift instrument clear from shipping container, open dust protection bag, and remove equipment.

2-1.3 Inspection

The instrument was carefully tested and inspected prior to shipment. Inspect the instrument for damage incurred during shipment. Check that the power cable is supplied with the test instrument. If the instrument is damaged in any way, notify the freight carrier immediately. Do not discard any packing materials, as the freight carrier's agent will wish to examine them.

2-2. PREPARATION FOR USE

The instrument is shipped ready for use. Required power source is 115 or 230 volts AC ±10%, single phase. The instrument is normally shipped with the 115/230 V switch in the 115 V position. For operation from 230 volts, follow the directions below:

2-2.1 Be sure the power cord is disconnected.

2-2.2 With a small screwdriver, move the 115/230 V switch on the rear panel to the 230 V position.

2-2.3 Connect the power cord between the LINE connector and power source.

2-2.4 This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument for safety. The offset center pin of the rear-panel three-prong LINE connector is the ground pin. It is recommended that the instrument be grounded to protect operating personnel. To preserve the protective feature of the instrument when operating from a two-contact outlet, use a two-prong adapter with the ground wire connected to a convenient ground point.

2-2.5 Do not disconnect the grounding wire for any reason; if line-related ground loops become evident, refer to the instructions in Section III.

2-3. MOUNTING

2-3.1 Bench Use

The power meter is normally supplied with rubber feet and a fold-away tilt stand for convenient bench operation. The tilt stand permits raising the front of the instrument so that the display and control markings can be seen easily.

2-3.2 Rack Mounting

To rack mount the power meter, necessary hardware including joining plates and corner brackets with handles are available as Model 9033. Instructions for rack mounting are provided with the hardware kit selected.

2-4. PACKAGING FOR SHIPMENT

If the instrument is to be packaged for shipment, use the original shipping container and packaging. If the original material has been discarded or is not in condition for re-use, perform the following packaging procedure:

2-4.1 Wrap the instrument in a heavy wrapping or plastic protective covering.

2-4.2 Place a protective cushion in the bottom of the shipping carton and place the instrument on the protective cushion.

2-4.3 Surround the remaining sides and top with additional protective cushions. Place front and rear protective cushions in such a manner as to provide support of the instrument without resting it on controls or connectors.

2-5. SHIPPING METHOD

This instrument should be shipped only by truck freight, rail freight, air freight, or parcel delivery service. If it is shipped by parcel post, damage is likely to occur. Systron-Donner is not responsible for units damaged in shipment, whether such units are in warranty or not.

2-6. INSURANCE

For your own protection, insure the unit for full value whenever it is shipped.

2-7. RETURNS FOR REPAIR

Be sure to fully identify any instrument that is returned to Systron-Donner or a Systron-Donner Service Center for repair of any kind, in-warranty or not. The paperwork with the unit must show the instrument serial number, a description of the problem or malfunction to be corrected, and the exact address to which the instrument should be returned when repair is completed. Please also include the name and telephone number of the cognizant party in your organization; this may speed the identification and repair of malfunctions.

SECTION III

OPERATING INSTRUCTIONS

3-1. SCOPE

This section contains descriptions of all operating controls and indicators for Models 4020A and 4021, an initial operating procedure, and a summary of hints and precautions for proper usage of the power meters.

3-2. FRONT PANEL CONTROLS AND INDICATORS

The front panel controls, indicators, and connectors for Model 4020A are illustrated in Figure 3-1, those for Model 4021 in Figure 3-2. The controls, indicators, and connectors illustrated are listed and described in Table 3-1.

3-3. REAR PANEL CONTROLS AND INDICATORS

The rear panel controls, indicators, and connectors for both power meters are illustrated in Figure 3-3 and described in Table 3-2.

3-4. INITIAL OPERATING PROCEDURES

Figure 3-4 contains condensed initial operating procedures for Models 4020A and 4021. These procedures are applicable to any RF power measurement situation.

Table 3-1. Front Panel Controls and Indicators

INDEX NO. (FIG. 3-1 OR 3-2)	FRONT PANEL NAME AND DESCRIPTION	FUNCTION
1	OVERRANGE indicator light	When illuminated, this light indicates that the reading of the digital display is erroneous. This will generally be due to excessive input power (greater than +13 dBm, or 20 mW) or because the unit has not been allowed enough warm-up time for the internal ovens to stabilize.
2	Polarity Indicator	Lights + to indicate that the reading of the digital display is above zero dBm (1.0 mW), or lights - to indicate a reading below 0 dBm.

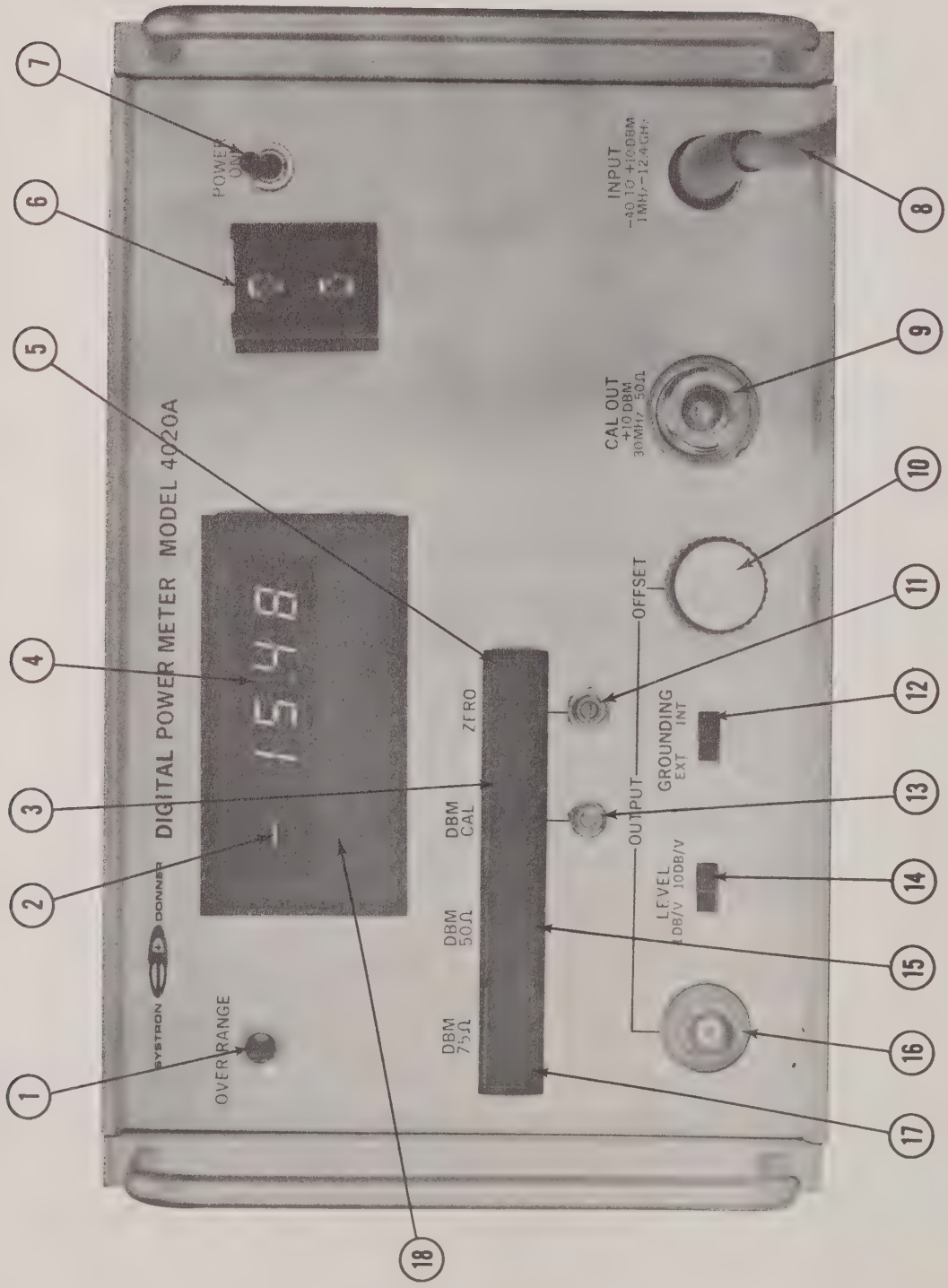


Figure 3-1. Model 4020A Front Panel Controls and Indicators

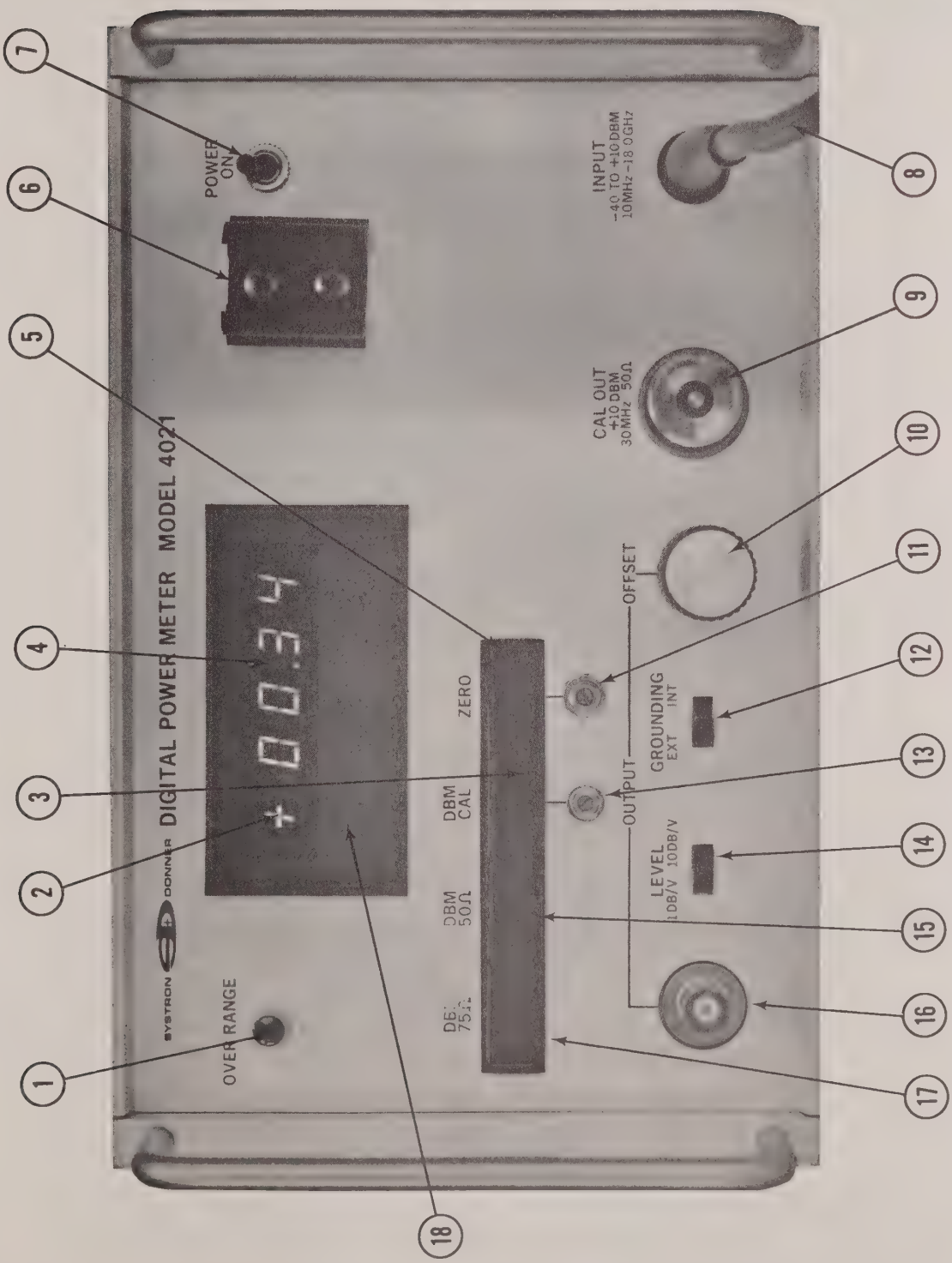


Figure 3-2. Model 4021 Front Panel Controls and Indicators

Table 3-1. Front Panel Controls and Indicators (Continued)

INDEX NO. (FIG. 3-1 OR 3-2)	FRONT PANEL NAME AND DESCRIPTION	FUNCTION
3	DBM CAL switch	This switch is mechanically interlocked with the DBM 75 Ω, DBM 50 Ω, and ZERO switches so that only one at a time may be depressed in normal operation. When the DBM CAL switch is depressed, the internal calibrator is activated so the unit may be calibrated to +10.00 dBm with the DBM CAL control.
4	Digital Display	Indicates the RF input power to the power head in terms of dBm (0 dBm = 1 mW into 50 or 75 Ω) from -40 to +10. Although the display will indicate readings below and above this range, such readings should be disregarded unless the unit has been calibrated from an external standard for these levels.
5	ZERO switch	When depressed, this switch converts the power meter from logarithmic to linear operation so that display zero may be set with the ZERO control. The power head should be connected to the CAL OUT connector.
6	Power Head Holder	To avoid damage to the power head, it should be stored in the holder when it is not in use or attached to the CAL OUT connector.
7	POWER ON toggle switch	Setting this switch to the "up" position connects AC power to the instrument.
8	INPUT connector and cable Model 4020A: Type N Male Model 4020: APC-7	RF power input is made through this connector; the detector is located within the body of the power head and delivers its output through the permanently-attached cable.
	CAUTION INPUT POWER LEVEL MUST NEVER EXCEED 50 mW (+17 dBm) PEAK, AVERAGE, OR CW FOR MODEL 4021. INPUT POWER FOR MODEL 4020A MUST NEVER EXCEED 100 mW (+20 dBm).	

Table 3-1. Front Panel Controls and Indicators (Continued)

INDEX NO. (FIG. 3-1 OR 3-2)	FRONT PANEL NAME AND DESCRIPTION	FUNCTION
9	CAL OUT connector Model 4020A: Type N Female Model 4021: APC-7	When the DBM CAL pushbutton has been depressed, this connector couples a 30 MHz, +10 dBm calibrating signal to the mating connector of the power head.
10	OFFSET control	This control is used to center the trace of an external oscilloscope or recorder connected to the OUTPUT jack.
11	ZERO adjustment	Used in conjunction with the ZERO pushbutton switch, ths control is adjusted for a reading of 00.00 on the digital display.
12	GROUNDING switch	When set to INT, this switch connects the outer conductor of the isolated OUTPUT BNC connector to the internal circuit ground of the power meter. Set to EXT, the ground is removed and must be supplied by the external oscilloscope or recorder.
13	DBM CAL adjustment	Used in conjunction with the DBM CAL pushbutton switch, this control is adjusted to match the display reading to the level of a power standard (+10.00 dBm when the internal calibrator output is used).
14	LEVEL switch	Selects the output range of the analog voltage to the oscilloscope or recorder; the maximum range is obtained at 10 DB/V and maximum sensitivity at 1 DB/V.
15	DBM 50 Ω switch	Depressing this switch sets up the internal circuitry to read power levels in a 50 Ω system when the detector probe is connected to the RF power source.
16	OUTPUT connector	This connector carries an analog voltage which is directly proportional to the level of RF input power to the probe; the proportion of 1 V or 0.1 V per indicated decibel is selected by the LEVEL switch. The shell of the connector is isolated from chassis ground.

Table 3-1. Front Panel Controls and Indicators (Continued)

INDEX NO. (FIG. 3-1 OR 3-2)	FRONT PANEL NAME AND DESCRIPTION	FUNCTION
17	DBM 75 Ω switch	Depressing this switch sets up the internal circuitry to read power levels in a 75 Ω system when the detector probe is connected to the RF power source through an appropriate 2 dB loss adapter. Adapters with loss factors other than 2 dB may be accommodated by an adjustment of A2R95, an internal calibration resistor (refer to Section V).
18	Panel Meter Zero Adjustment	Used to zero the panel meter reading during calibration; not normally used during operation.

Table 3-2. Rear Panel Controls and Indicators

INDEX NO. (FIG. 3-3)	REAR PANEL NAME AND DESCRIPTION	FUNCTION
1	LINE connector	Grounded IEC-approved 3-pin connector. Accepts line power input through the supplied power cord.
2	FUSE holder	To remove fuse, push fuseholder cap in and rotate CCW. To install fuse, insert the fuse in the cap, then push the cap into the fuseholder and rotate fully CW.
3	115/230 V selector	Sets voltage level at which the power meter is to operate. To change voltages, unplug power connector, then move switch.
	CAUTION DO NOT CHANGE VOLTAGES WITH THE POWER CORD CONNECTED. SERIOUS DAMAGE TO THE INSTRUMENT COULD RESULT IF THIS CAUTION IS IGNORED.	

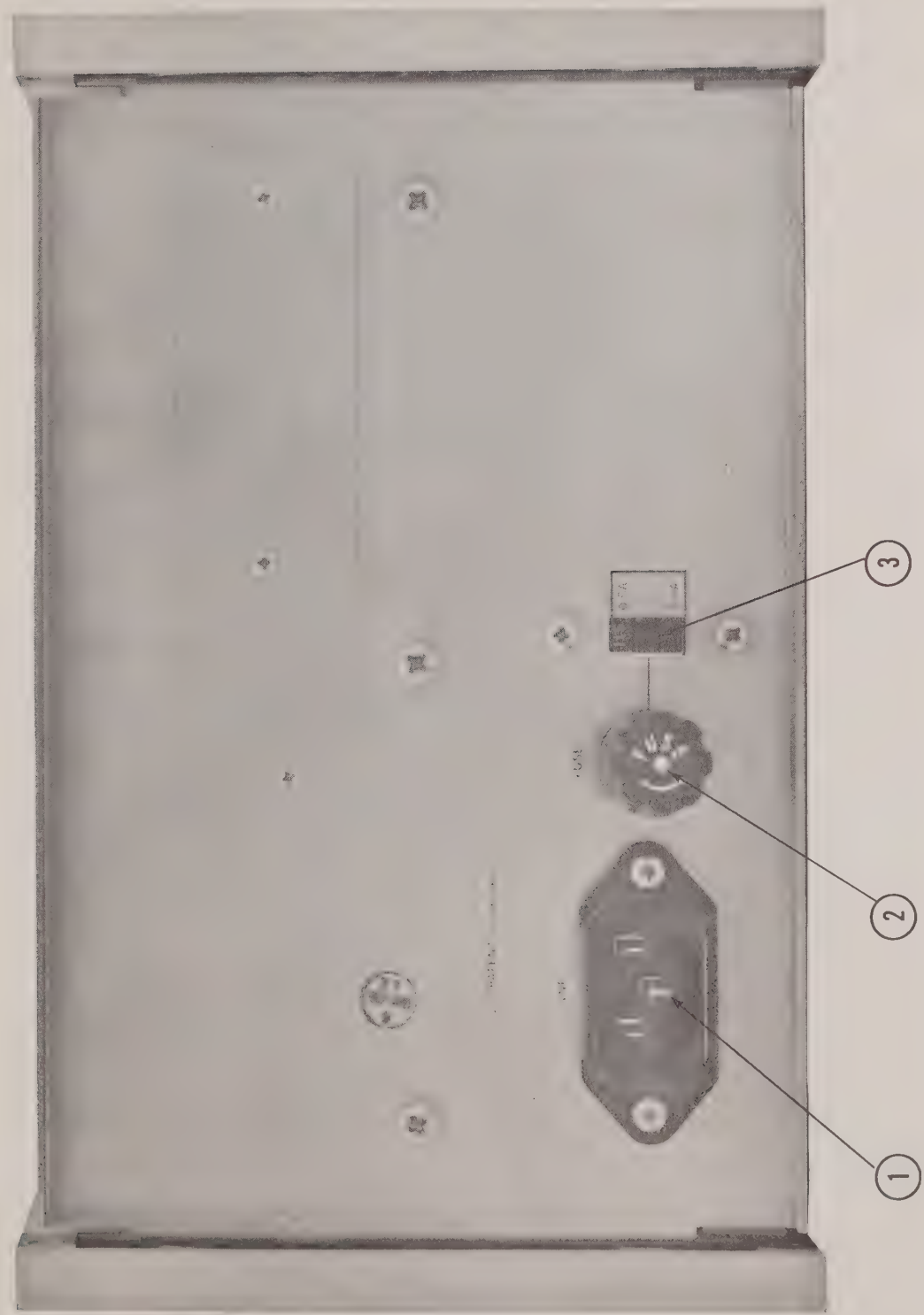
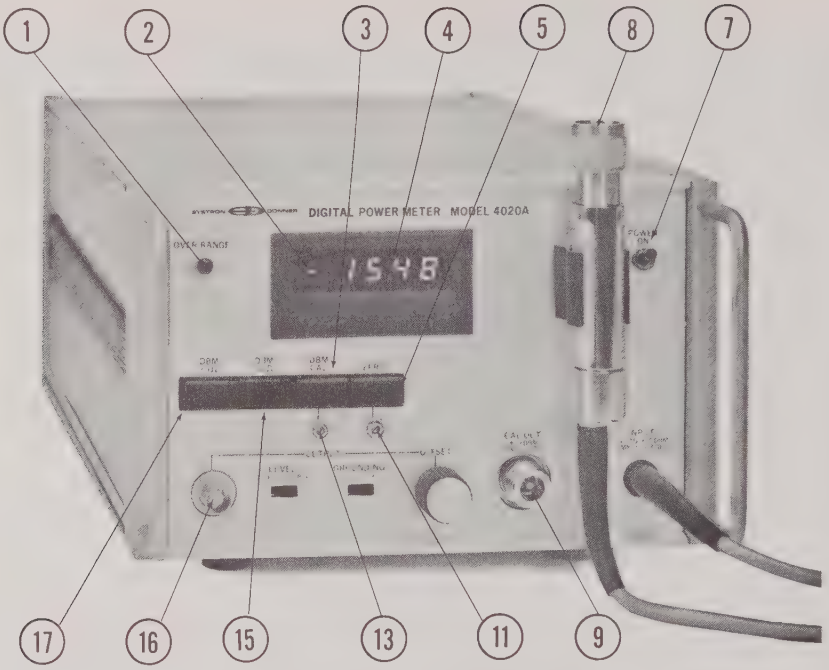


Figure 3-3. Rear Panel Controls and Indicators



A. Turn the power on (7); the digital display (4) and polarity indicator (2) will light, and the OVERRANGE light (1) may be illuminated. The readings on the digital display at this time are meaningless.

B. Connect the power head (8) to the CAL OUT connector (9) and press the DBM CAL switch (3).

C Allow at least 5 minutes for the unit to stabilize. At temperatures below normal room temperatures, this may take longer. During the warm-up period (while the internal ovens are stabilizing), power readings will be higher than the actual value of RF from the calibrator, and ripple voltage will appear at the OUTPUT connector (16).

D. To minimize thermal drift, handle the power head (8) as little as possible. Try not to touch the head near the back end (near the output cable), as this is where the temperature compensation components are located. When connecting a warm head to a cold connector (or vice versa), allow extra time for the two temperatures to equalize.

Figure 3-4. Initial Operating Procedure
(Sheet 1 of 2)

E. Press the ZERO pushbutton (5) all the way in until it latches. Check the reading -- it should be 00.00, with the polarity indicator off or alternating between + and -. The last digit may be alternating between 0 and 1, but this is a normal indication of some thermal noise. If necessary, adjust the ZERO trimmer (11) for the proper indication.

F. The ZERO adjustment (11) should be checked at the start of each day, and again after about 30 minutes (more often where ambient temperatures fluctuate during the day). For very precise measurements of low power levels, the power meter should be zeroed before each reading.

G. Press and latch the DBM CAL pushbutton (3). The reading should be +10.00. If it is not, adjust the DBM CAL trimmer (13) until the reading is correct.

H. If it was necessary to adjust the DBM CAL trimmer (13), re-check (and adjust if necessary) the zero reading.

I. Press the DBM CAL (3) and DBM 75 Ω (17) pushbuttons at the same time; both should latch in place. The reading should be +12.00; the extra 2 dB makes up for the loss in 50 to 75 Ω adapters.

J. Remove the power head from the CAL OUT jack (9), then connect it to an external source of RF known to be below the 10 mW (+10 dBm) level.

K. Depress the DBM 50 Ω pushbutton (15) and read the power level on the digital display.

L. Turn off the RF power source, but leave the detector probe connected. Depress the ZERO pushbutton (5), and check for a reading of 00.00. If the outer conductor of the RF source has the same earth/ground potential as the outer conductor of the power meter CAL OUT jack (9), it is possible to zero the instrument without bothering to disconnect the probe from the RF source. It is not possible to zero the instrument if there is any RF turned on.

M. Connect the power head to a source of 75 Ω RF through an appropriate 2 dB-loss adapter. Depress the DBM 75 Ω pushbutton (17), and read the power level.

Figure 3-4. Initial Operating Procedure
(Sheet 2 of 2)

3-5. HINTS AND PRECAUTIONS

3-5.1 Measuring Power

After first determining that the power output level of the device to be measured does not exceed +10 dBm (10 mW), connect the detector probe of the power meter to the RF source. If there is any chance that this power level will be exceeded, or if the power level is not known, use attenuators: see Paragraph 3-5.3. Depress the DBM 50 Ω or the DBM 75 Ω pushbutton; the reading on the digital display is the RF power level in dBm. These readings may be converted to mW with the aid of the conversion chart shown as Figure 3-5.

The formula for conversion of power level, in millwatts, to dBm (where zero dBm is equal to 1.0 mW into 50 Ω) is:

$$dBm = 10 \times (\text{Log}_{10}\ mW)$$

To convert the dBm readings of the power meter to the equivalent power level in milliwatts, use the following formula:

$$mW = 10^{(dBm \div 10)}$$

3-5.2 Measuring Low Power

The accuracy of readings below -30 dBm can be improved, and the usable low power point of the meter increased to -45 dBm or below by recalibrating the front-panel controls using an external 30 or 40 dB precision attenuator at the CAL OUT connector. Zero the meter, then depress the DBM 50 Ω (or DBM 75 Ω) pushbutton and adjust the DBM CAL trimmer for the desired power level.

NOTE

Be sure to recalibrate the meter at zero and +10 dBm when the low power measurements are concluded and you wish again to measure power in the normal operating range of the instrument.

3-5.3 Measuring High Power

The power meter can be used to measure power levels in excess of its normal upper limit of +10 dBm (10 mW) if appropriate attenuators are used, or if the detector probe is connected to the auxiliary arm of a directional coupler.

3-5.4 Swept RF Measurements

To use the power meter as a logarithmic converter driving an external display, perform the following procedures:

1. Connect a BNC-BNC cable between the power meter OUTPUT connector and the input connector of an X-Y CRT display unit. This unit should be a Systron-Donner Model 7000 Display Unit with (in order of preference) a 7010 M1 or 7010 vertical plug-in. The 1 MΩ input impedance and differential operation make the 7010 M1 the best choice for accurate readings at low power levels (-30 dBm and below).

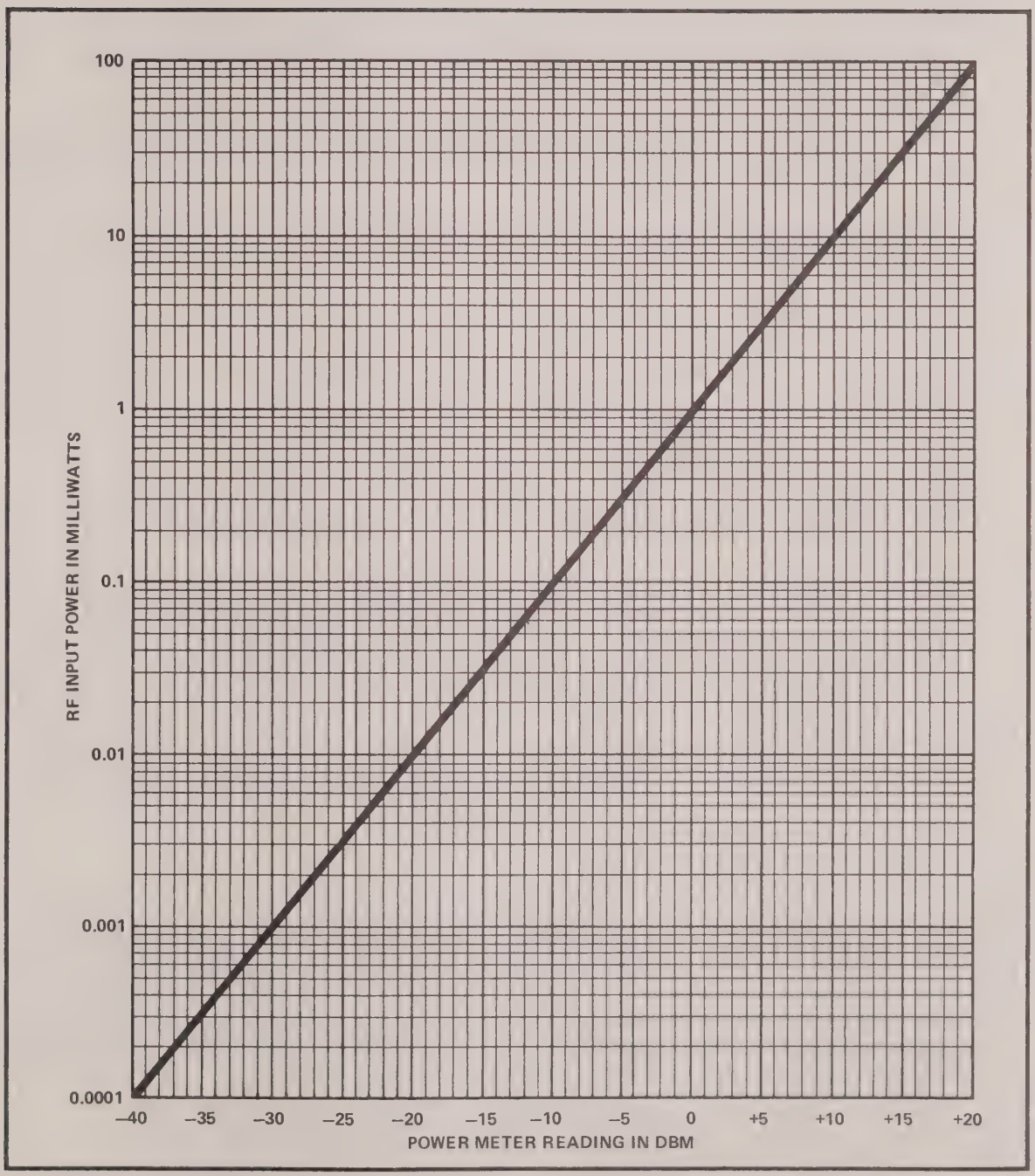


Figure 3-5. DBM to Power Level Conversion Chart

2. With all input signals disconnected from the display unit, set the vertical deflection factor to 1 V/division and center the trace with the plug-in offset or position control.

3. If the input is being made to a dual-input differential vertical amplifier, an adapter should be used to convert the single BNC output of the power meter to the dual BNC input of the amplifier.

4. Set the GROUNDING switch to INT and the LEVEL switch to 10 DB/V. Connect the power head to the CAL OUT connector and check the zero and +10 dBm levels; adjust if necessary.

5. Connect the power head to the point of measurement. Center the trace on the display CRT with the OFFSET control.

NOTE

The trace centering on the CRT display itself was set in step 2. This is the normal operating procedure: set the trace centering with no input signal, then use the power meter OFFSET control to re-center the trace.

6. If the level of the CRT presentation is too low, set the LEVEL switch to 1 DB/V. The output will saturate at $\approx \pm 5$ V in this position.

7. If the CRT trace is distorted by ground loops, move the GROUNDING switch to EXT. The ground loop usually exhibits itself as a single cycle of distorted line-frequency sine wave at either end of the trace. It is not recommended that you attempt to solve ground-loop problems by opening the third (ground) wire connection to the oscilloscope or display unit chassis; this action could place the operator in danger. Instead, use a high-impedance differential input oscilloscope or display unit. The Systron-Donner Model 7000 with 7010 M1 plug-in was designed to be used with the Model 4020A and Model 4021. Finally, it will help if the power meter and display unit are both operated from the same power line.

3-5.5 Use as Transfer Standard

The power meter has excellent short-term stability, and may be used as a transfer standard to calibrate other power meters throughout your facility. Using a secondary power calibration standard, determine the deviation from absolute (the secondary standard) of the +10.00 dBm calibration oscillator in the power meter. Be sure to allow sufficient time for stabilization and to zero and calibrate the meter before determining error. Also, be sure to allow sufficient time for stabilization and to zero and calibrate the meter before using it as a standard to calibrate other meters. Finally, be sure to take into account the deviation from absolute measured earlier.

3-5.6 Measuring Distorted Waveforms

Non-sinusoidal waveforms can be properly measured if the power meter is used correctly. For maximum accuracy when measuring distorted waveforms with large harmonic content,

keep the power input below -15 dBm for Model 4020A, below -18 dBm for Model 4021. At these levels, the power meter is a square law device measuring true RMS power; at +10 dBm, it reads a value approaching the negative peak.

Figure 3-6 shows the accuracy improvement at low power levels with distorted waveforms.

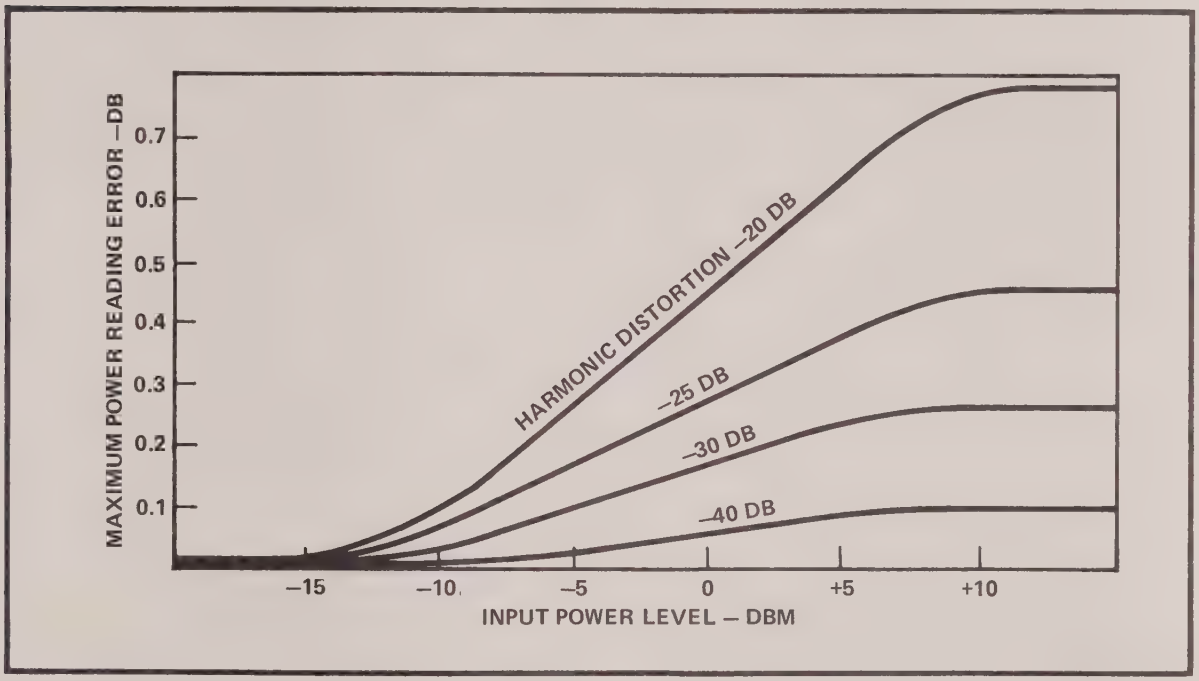


Figure 3-6. Worst Case Errors as a Function of Power Level with Distorted Waveforms

3-5.7 Use and Care of APC-7 Connectors (Model 4021 Only)

For maximum life and best service from the precision 7 mm connector used on the power head of the 4021, connect it using the following method:

1. Retract the coupling sleeve on the power head connector by turning the coupling nut counterclockwise until the sleeve and nut disengage.

2. If the mating connector has a coupling sleeve, fully extend it by turning the coupling nut clockwise. To engage coupling sleeve and coupling nut when the sleeve is fully retracted, press back lightly on the nut while turning it clockwise.

3. Push the connectors firmly together, and thread the coupling nut of the connector with retracted sleeve over the extended sleeve.

4. Close the gap between coupling nuts with the nut on the extended sleeve connector.

To disconnect the two connectors loosen the coupling nut of the connector showing the wider gold band.

IMPORTANT

Part the connectors carefully to prevent striking the inner conductor contact.

Care for the APC-7 connector by keeping contacting surfaces smooth and clean. Irregularities and foreign particles can degrade electrical performance.

Protect the contacting surfaces when the connector is not in use by leaving the coupling sleeve extended. Refer to Paragraph 6-2 for connector service information.

SECTION IV

CIRCUIT DESCRIPTION

4-1. OVERALL FUNCTIONAL DESCRIPTION

Simplified circuit diagrams of the Model 4020A and 4021 power meters are shown in Figures 4-1 and 4-2. Referring to Figure 4-1, the detector output, E_{dc}, is fed through R_D to the current summing junction of the input amplifier. E_{dc} is also applied to the computer amplifier through the thermistor and a 470 kΩ resistor. The compensation output current of the computer amplifier is fed into the current summing junction of the input amplifier such that the total current into the input amplifier is $I_{dc} + I_{comp}$. A transistor logging element is used in the feedback loop. The output voltage of this amplifier is equal to the logarithm of the input current.

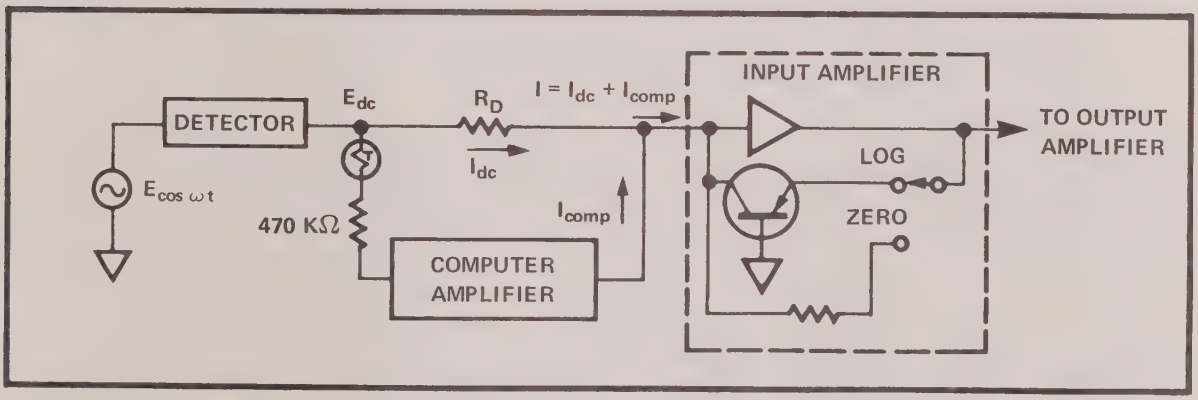


Figure 4-1. Compensation and Input Amplifier Simplified Schematic Diagram

When the ZERO pushbutton is depressed, the power meter operates in a linear, not a logarithmic mode. In this linear mode, each increment of the least significant display digit (the .01 dB digit) represents ≈ 3 nW. It is not possible to correlate readings displayed in the linear (zeroing) mode with readings displayed in the logarithmic (dBm) mode.

Figure 4-2 shows the output amplifier and a simplified version of the output switching. The first stage of the output amplifier is used to amplify the logarithmic output of the input amplifier. All logarithmic offsets are summed by the second stage and applied to the output circuitry. The output amplifier is used only in the logarithmic mode; in the linear (zeroing) mode, the output of the input amplifier is applied directly to the digital display.

4-2. DETECTOR COMPENSATION

Crystal diode detectors have been used to measure RF power for some time, but until recently their useful measurement range has been restricted to the square law region where output voltage is approximately proportional to input power. In reasonably fast-response

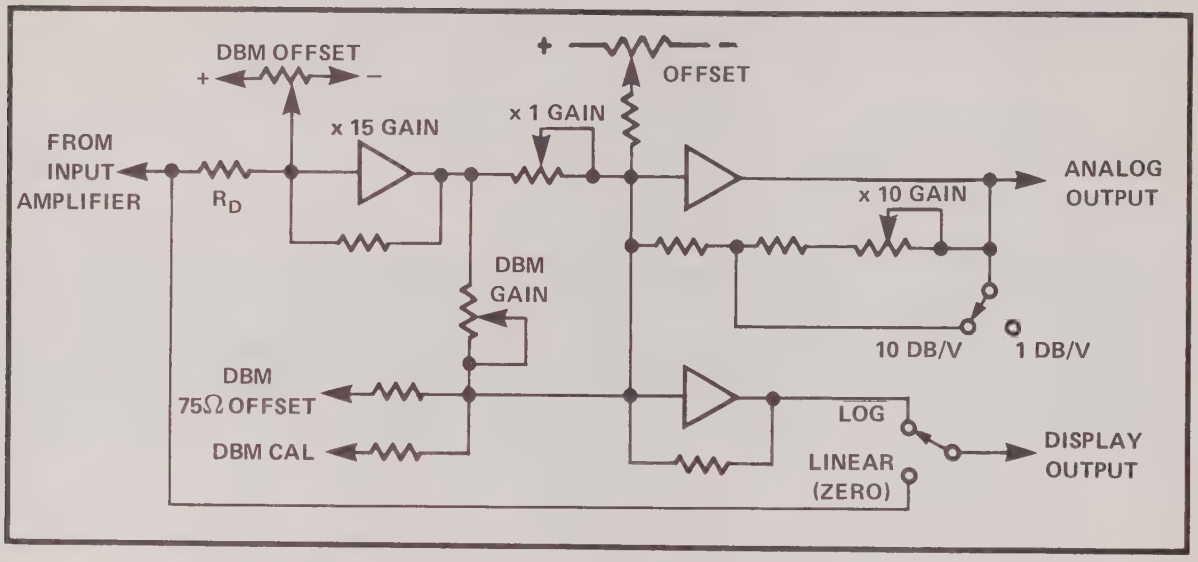


Figure 4-2. Output Amplifier Simplified Schematic Diagram

applications, the lower end of the measurement range is limited by noise to about -40 dBm (0.1 μW). The upper end of the usual measurement range occurs at about -10 dBm where the detector output response begins to depart significantly from square law. In Systron-Donner power meters, a compensation signal is generated which, when it is added to the detector output, is proportional to RF power input to levels beyond +10 dBm. This is possible because of the predictable behavior of the diodes used in crystal detectors.

Figure 4-3 shows the schematic of the 4020A crystal detector. The crystal diode, CR1, rectifies the RF voltage across the terminating resistor, R_t. In the Model 4020A and Model 4021, R_t is a precision 50 Ω termination and CR1 is a microwave point contact diode. The relationship between the peak RF input voltages, $E_{\cos\omega t}$, and the detector dc output, E_{dc}, is described by the following equation:

Let $E_{\cos\omega t}$ = RF Voltage across Termination R_t

E_{dc} = Output Voltage of a Detector

R_v = Low level video resistance of the Detector Diode

R_L = Load resistance for the Detector

I_o = The zero order modified Bessel function of the first kind,

and $\propto$ = is proportional to $\frac{q}{kT}$, where:

q = Charge of an Electron,

k = Boltzmann's Constant, and

T = Absolute Temperature, then:

$$\left[1 + \left(\frac{R_v}{R_L}\right) \propto E_{dc}\right] \exp\left(\propto E_{dc}\right) = I_o\left(\propto E_{\cos\omega t}\right) \qquad \text{(Equation 1)}$$

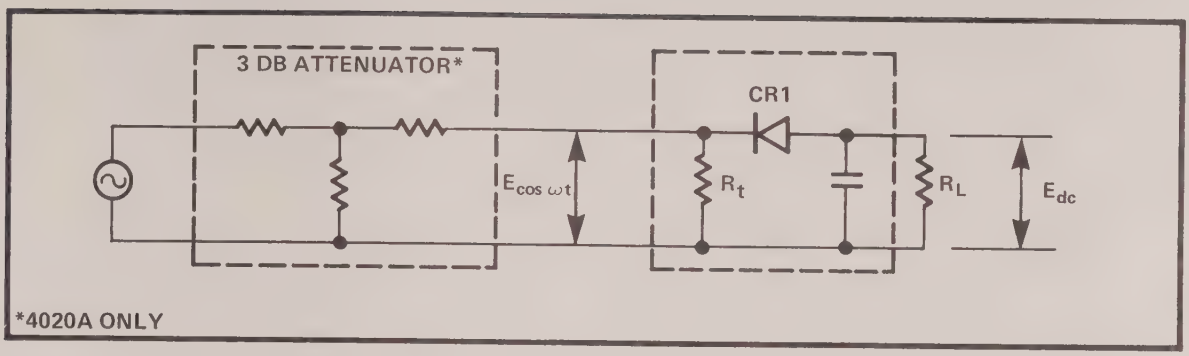


Figure 4-3. Detector Schematic Diagram

For power levels less than -20 dBm, if $K = R_V/R_L$, Equation (1) can be approximated by:

$$E_{dc} = \frac{(E_{\cos \omega t})^2}{4\,(1 + K)} \qquad \text{(Equation 2)}$$

The square law relationship described in Equation (1) shows that the detector dc output is proportional to the square of RF input voltage, which in turn is proportional to the RF input power. Equation (2) describes the desired detector response, while Equation (1) describes the actual detector response.

A 3 decibel attenuator, shown in Figure 4-3, is used in Model 4020A to improve load matching and input VSWR. Model 4021, which requires higher CR1 sensitivity for measurements in Ku band, does not use an input attenuator.

The compensation amplifier in the power meter generates a signal equal to the difference between the detector outputs described by Equation (2) and Equation (1). The resulting compensation signal is added to the detector output described in Equation (1), and the resultant sum of signals provides a response described by Equation (2). This compensation is effective to power levels greater than +10 dBm; however, it is temperature-dependent. However, the temperature dependence of the diode parameters is predictable, and a thermistor network may be used to maintain accurate compensation over a temperature range of +18 to +45°C. The thermistor network maintains the compensation accurately only for relative (rather than absolute) power measurements over the temperature range. By design, this temperature dependence has been minimized in the 4020A and 4021. Furthermore, the instrument is equipped with a calibrator so that accurate absolute power measurements are easily made at any temperature between +18 and +45°C.

4-3. DETAILED CIRCUIT THEORY

4-3.1 Input Amplifier

A simplified circuit diagram of the input amplifier is shown in Figure 4-4. This amplifier consists of a high-gain, chopper-stabilized operational amplifier capable of being operated in logarithmic or linear mode by selection of its feedback network.

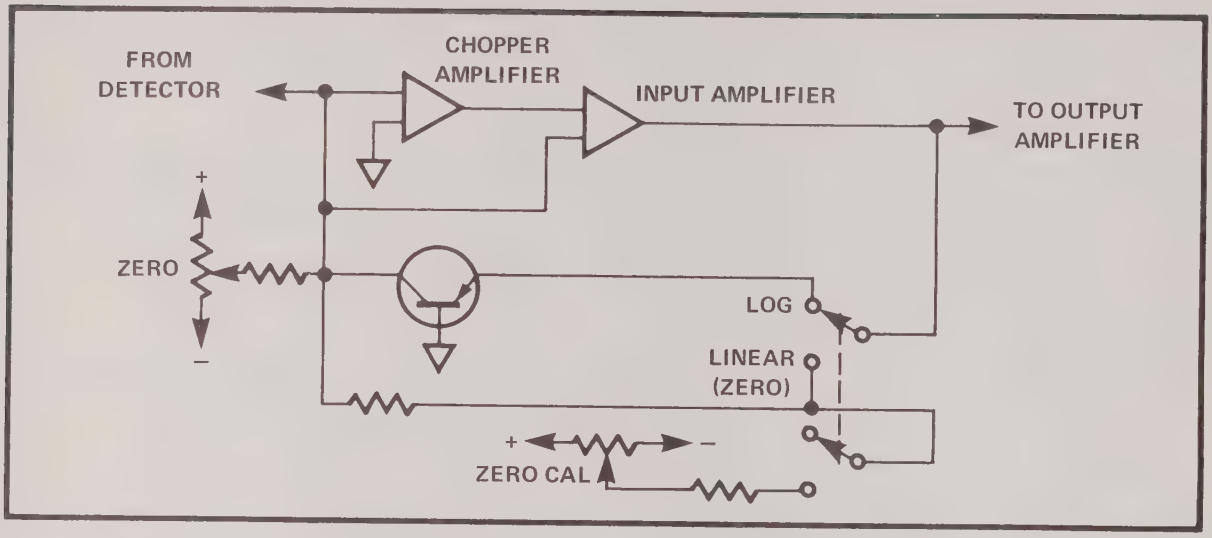


Figure 4-4. Input Amplifier Simplified Schematic Diagram

To operate the input amplifier in the logarithmic mode, a transistor is used in the feedback loop around the operational amplifier. Referring to Figure 4-4, I_{in} is proportional to e (qE/kT), since the operational amplifier has very high gain. Thus E_o is proportional to log I_{in}.

This logarithmic relationship between I_{in} and E_o holds over many decades of current because parasitic collector currents in the logging transistor are eliminated by operating its collector-base junction at zero volts. When operated in the logarithmic mode, the output level of this amplifier is approximately 6.7 mV/dB, and is a function of the temperature of the logging transistor. To maintain the logarithmic coefficient independent of ambient temperature, the logging transistor is mounted in a temperature-controlled oven and held at +60°C. A power transistor serves to heat the oven, and a thermistor mounted in the oven senses temperature. A one-stage amplifier is connected between the thermistor and the transistor heater amplifier. When the oven is at its correct temperature, the driver amplifier generates just enough heat to maintain the oven at its proper temperature (refer to Figure 4-5).

The chopper-stabilized operational amplifier has a high gain and is essentially free from dc drift. The action of the chopper amplifier holds the input summing junction of the operational amplifier at zero volts.

4-3.2 Computer Amplifier

Figure 4-6 is a simplified schematic diagram of the computer amplifier. The first stage logs the detector output and adjusts the level at which compensation becomes significant. Second-stage output is fed to an anti-log transistor whose collector delivers the compensation current to the input amplifier summing junction.

E_{dc} is applied to the logging stage of the computer amplifier through a thermistor and a 470 kΩ resistor. The thermistor changes the correction signal such that level compensation is independent of temperature from +18 to +45°C. E_{dc} is logged in the computer amplifier in

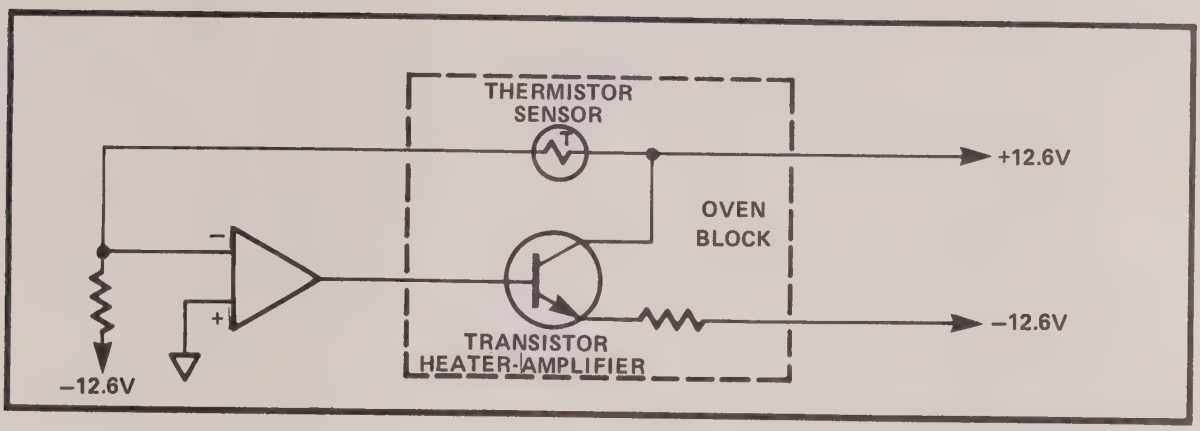


Figure 4-5. Oven Controller Simplified Schematic Diagram

precisely the same manner as it is logged in the input amplifier. Because of its temperature sensitivity, the logging transistor in the computer amplifier is also placed in the oven to keep the logging sensitivity independent of temperature. Since the correction signal does not become significant until detected RF power levels are above -30 dBm, the computer logging amplifier need not be as stable as the input logging amplifier. Consequently, this amplifier is not chopper-stabilized. The x1.9 amplifier drives the anti-logging transistor, which sets the compensation for the detector by adding a signal to the input amplifier. As in the case of the logging transistor, the anti-logging transistor is temperature-sensitive and is also placed in the temperature-controlled oven.

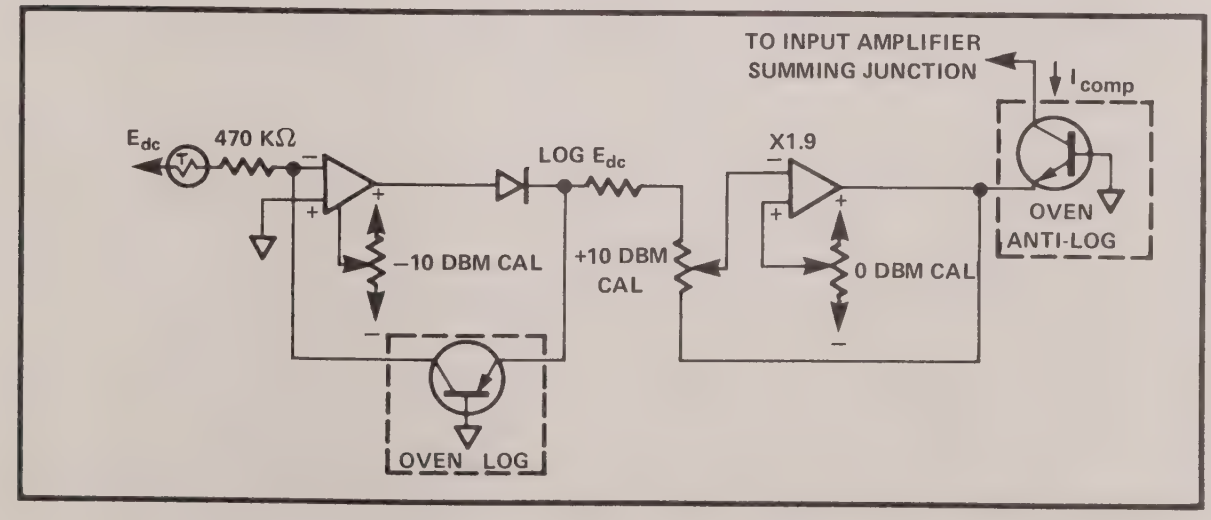


Figure 4-6. Computer Amplifier Simplified Schematic Diagram

4-3.3 Output Amplifier

A simplified circuit diagram of the output amplifier is shown in Figure 4-2. The output amplifier consists of three stages and is used only in the logarithmic modes. The first stage multiplies the log signal from the input amplifier by 15 to give a log sensitivity of 100 mV/dB at its output. This signal is applied to the current summing junctions of the display amplifier and the analog output amplifier. The sensitivity of the current summing junctions is 10 μA/dB. Log calibration and 75 Ω output signals are also applied to the summing junction of the display output amplifier, and the offset is applied to the analog output amplifier. The second stage amplifier for the display converts its current input to a voltage, resulting in an output level of 100 mV/dB, which is applied to the digital display. The second-stage amplifier for the analog output converts its current input to a voltage that gives an output of 100 mV/dB or 1 V/dB, depending on the position of the front panel LEVEL switch.

4-3.4 Digital Display

The display output of the output amplifier is coupled to the input of a digital panel meter which performs the function of converting a dc voltage into a row of digits to be read by the user. Basically, it is an analog-to-digital converter (ADC) whose output drives seven-segment light-emitting diode readouts. The readouts are driven sequentially (strobed) at a rate imperceptible to the human eye, so that some of the circuits can be time-shared. This results in considerable simplification, as these circuits would otherwise have to be duplicated. The digital panel meter used is an integrated, sealed unit which has a maximum possible range of + or -99.99 dB.

4-3.4 Calibrator

The calibrator consists of a 30-MHz oscillator, 30 MHz low-pass filter, and a 4-dB, 50 Ω attenuator. CALIBRATOR OUTPUT is from a front panel connector (APC-7 connector for Model 4021, Type N for Model 4020A).

The 30-MHz calibrator oscillator is operated within a very stable amplitude-regulating loop so that its output level is a function of a reference voltage. The calibrator output level is set by adjusting the reference voltage divider. The oscillator output is fed to the low-pass filter from a 50 Ω resistor tapped into the 30-MHz resonant circuit.

SECTION V

PERFORMANCE CHECKS AND CALIBRATION

5-1. SCOPE

The Systron-Donner Models 4020A and 4021 Power Meters are rugged instruments and should give many years of trouble-free operation. Routine, simple tests can be made periodically to give assurance that the instruments are accurately calibrated and operating properly. This section of the manual describes these tests.

Repairs or calibration accuracy checks should be undertaken only by qualified personnel with sufficient experience and knowledge to ensure that proper test methods are employed. Use standard maintenance practices when working on the instrument.

5-2. PERFORMANCE CHECKS

The following performance checks may be performed at any time, and should be performed annually. If these checks reveal the need for re-calibration of the instrument, it should be returned to a Systron-Donner Service Center (as shown on the warranty card at the front of this manual) or another qualified standards laboratory, so that the calibration procedure in Paragraph 5-3 may be accomplished.

5-2.1 Power Linearity Check

This check requires the use of a precision set of attenuators (Type N connectors for Model 4020A or APC-7 connectors for Model 4021). One 10 dB and two 20 dB attenuators are required. (Such attenuators as Systron-Donner Model 441A, with Type N connectors, or Model 447, with APC-7 connectors, are appropriate for this application.) Satisfactory demonstration of proper performance can be obtained in the field if the attenuators used are accurately calibrated, or if the error is known from previous measurement in a standards laboratory. A calibrated 50 Ω step attenuator may be used in place of the fixed 10 and 20 dB units:

1. Turn on instrument power, and allow the unit to operate for 20 to 30 minutes.

2. Connect the power head to the CAL OUT connector, depress the ZERO switch, and adjust the front panel ZERO trimmer for a reading of ±00.00.

3. Depress the DBM CAL switch and adjust the front panel DBM CAL trimmer for a reading of +10.00 dBm.

4. Using a calibrated step attenuator, or a set of precision attenuators, check the reading of the display at the attenuation levels shown in Table 5-1. If a step attenuator is used, it should be inserted in the line between the CAL OUT and power head connectors using low-loss cables; steps 2 and 3 must then be repeated.

Table 5-1. Power Linearity Check Values

ATTENUATION	DISPLAY READING	TOLERANCE (EXCLUDING ATTEN-UATOR ERROR)	READING RANGE
0 dB	+10.00 dBm	None allowed	+10.00
10 dB	±00.00 dBm	±.02 dB	-00.02 to +00.02
20 dB	-10.00 dBm	±.04 dB	-09.96 to -10.04
30 dB	-20.00 dBm	±.06 dB	-19.94 to -20.06
40 dB	-30.00 dBm	±0.1 dB	-29.90 to -30.10
50 dB	-40.00 dBm	±0.14 dB	-39.86 to -40.14

5-2.2 Input VSWR Check

5-2.2.1 EQUIPMENT REQUIRED. This check requires a precision sweep generator which can produce a leveled sweep output over the 10 MHz to 12.4 GHz (Model 4020A) or 10 MHz to 18 GHz (Model 4021) range. If the generator used has internal leveling capability, an external directional detector for leveling is not required. If it does not, an external leveler must be used. In addition, a second directional coupler and microwave crystal detector must be used to feed a display unit calibrated in return loss or VSWR. Figure 5-1 shows a typical test setup for measuring reflected power.

The following factors will influence the accuracy of these measurements:

1. Flatness error of the internal or external sweeper leveler
2. Errors in any RF adapters (Type N to APC-7, etc.) used
3. Flatness error of the directional coupler used for reflected power measurement
4. Flatness error of the microwave crystal detector used for reflected power measurements
5. Absolute error, flatness error, and VSWR of the precision termination used as reference.

Tables 5-2 and 5-3 list various models of test equipment which may be used for this performance check, keyed by the specified performance parameters of the power meter.

5-2.2.2 ALTERNATE EQUIPMENT. Instead of the directional coupler and crystal detector used to measure reflection coefficient, a precision RF bridge may be used to measure input VSWR. The manufacturer's instructions should be observed for the method of making swept VSWR measurements with these devices. Some applicable models are:

1. Wiltron 60NF50, 50 to 2000 MHz for Model 4020A, Type N Female Connector

2. Wiltron 60A50, 5 to 2000 MHz for Model 4021, Type APC-7 Connector

3. Wiltron 87A50, 2 to 18 GHz for Model 4020A or 4021, Type APC-7 Connector (appropriate adapters required for 4020A)

5-2.2.3 PROCEDURE.

1. Connect the test equipment as shown in Figure 5-1. Do not connect the power meter yet.

2. Adjust the sweeper amplitude controls for a leveled output of no more than 10 mW (+10 dBm).

3. Adjust the frequency controls of the sweeper to cover the frequency bands detailed in Tables 5-2 and 5-3.

4. Calibrate the display by measuring the VSWR of a precision termination and a calibrated mismatch or precision short.

5. Connect the power head of the 4020A or 4021 to the output of the directional coupler and measure the VSWR over the specified bands (the power meter need not be turned on for these tests).

6. Repeat the tests as many times as necessary with the different sweeper plug-ins, directional detectors, and directional couplers to verify that input VSWR is within the limits specified in Tables 1-1, 5-2, and 5-3.

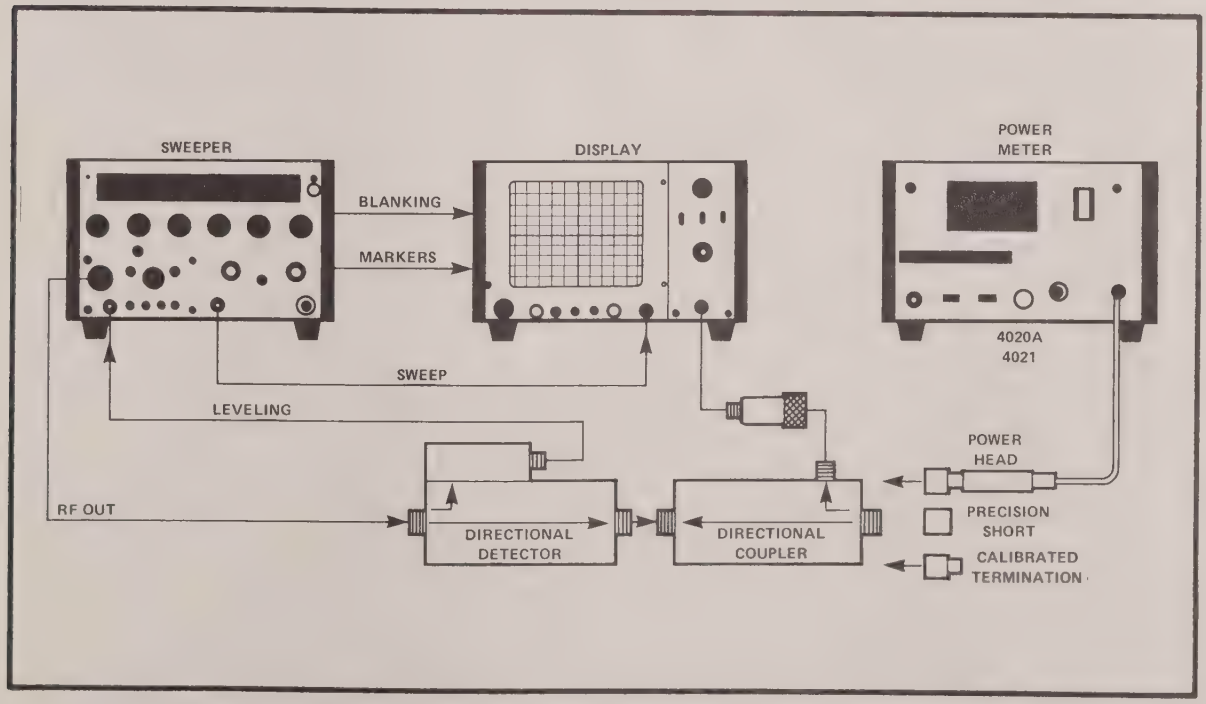


Figure 5-1. Setup for Reflected Power and VSWR Measurements

Table 5-2. Equipment Recommendations and Specifications for Model 4020A VSWR Performance Check

FREQUENCY RANGE	SYSTRON-DONNER SWEEP GENERATOR MODELS				DIRECTIONAL COUPLER	CRYSTAL DETECTOR	50Ω TERMINATION	SHORT	POWER METER PERFORMANCE		
	MAINFRAME	PLUG-IN	LEVELER	FLATNESS					VSWR	RETURN LOSS	REFLECTED POWER
10 MHz to 4.0 GHz									≤1.15:1	≥ 23 dB	≤ 7%
10-110 MHz	5000A	5007	1025★	±0.1 dB	Narda♦ 3060	S-D* 306	S-D* 451A	S-D* 961-1			
100-500 MHz	5000A	5008-1	1025★	±0.2 dB	S-D* 1014	S-D* 306▲	S-D* 451A	S-D* 961-1			
500-1000 MHz	5000A	5010	1025■	±0.2 dB	Narda♦ 3041	S-D* 306	S-D* 451A	S-D* 961-1			
1.0-2.0 GHz	5000A	5011	1031■	±0.25 dB	Narda♦ 3042B	S-D* 306	S-D* 451A	S-D* 961-1			
2.0-4.0 GHz	5000A	5013A	1033	±0.3 dB	Narda♦ 3043B	S-D* 306	S-D* 451A	S-D* 961-1			
1.0-4.0 GHz	5000A	5030	1026	±0.4 dB	S-D* 1026	Included	S-D* 451A	S-D* 961-1			
10 MHz to 4.0 GHz	540B	571B	Internal	±0.7 dB	S-D* 1025/1026	Included	S-D* 451A	S-D* 961-1	≤1.15:1	≥ 23 dB	≤ 7%
4.0 to 8.0 GHz	5000A	5014	1034	±0.4 dB	Narda♦ 3044B	S-D* 306	S-D* 451A	S-D* 961-1	≤1.22:1	≥ 20 dB	≤ 10%
8.0 to 12.4 GHz	5000A	5015	1035	±0.7 dB	Narda♦ 3045C	S-D* 306	S-D* 451A	S-D* 961-1	≤1.35:1	≥16.5 dB	≤ 17.7%
4.0 to 12.4 GHz	540B	572-5	Internal	± 1 dB	Narda♦ 3202B	S-D* 306	S-D* 451A	S-D* 961-1			

*Systron-Donner Corporation, Van Nuys, CA ♦ Narda Microwave Corporation, Plainview, L.I., NY ★ Or Internal Leveling ■ Or Internal Leveling with Option M2 Plug-in
▲ Appropriate Between-series RF Adapters Required

Table 5-3. Equipment Recommendations and Specifications for Model 4021 VSWR Performance Check

FREQUENCY RANGE	SYSTRON-DONNER SWEEP GENERATOR MODELS				DIRECTIONAL COUPLER	CRYSTAL DETECTOR	50Ω TERMINATION	SHORT	POWER METER PERFORMANCE		
	MAINFRAME	PLUG-IN	LEVELER	FLATNESS					VSWR	RETURN LOSS	REFLECTED POWER
10 MHz to 4.5 GHz									≤1.22:1	≥ 20 dB	≤ 10%
10-110 MHz	5000A	5007	1025★	±0.1 dB	S-D* 1014▲	Krytar† D100▲	S-D* 457	S-D* 961-5			
100-500 MHz	5000A	5008-1	1025★	±0.2 dB	S-D* 1014▲	Krytar† D100▲	S-D* 457	S-D* 961-5			
500-1000 MHz	5000A	5010	1025■	±0.2 dB	S-D* 1014▲	Krytar† D100▲	S-D* 457	S-D* 961-5			
1.0-2.0 GHz	5000A	5011	1031■	±0.25 dB	Narda♦ 3092	Krytar† D100‡	S-D* 457	S-D* 961-5			
2.0-4.0 GHz	5000A	5013A	1033	±0.3 dB	Narda♦ 3093	Krytar† D100‡	S-D* 457	S-D* 961-5			
4.0-4.5 GHz	5000A	5014	1034	±0.4 dB	Narda♦ 3093	Krytar† D100‡	S-D* 457	S-D* 961-5			
10 MHz-4.2 GHz	540B	571B	Internal	±0.7 dB	S-D* 1025/1026▲	Included	S-D* 457	S-D* 961-5			
4.2-4.5 GHz	540B	572	Internal	± 1 dB	Narda♦ 3094	Krytar† D100‡	S-D* 457	S-D* 961-5			
4.5 to 7.0 GHz	5000A	5014	1034	±0.4 dB	Narda♦ 3094	Krytar† D100‡	S-D* 457	S-D* 961-5	≤1.35:1	≥16.5 dB	≤ 17.7%
4.5 to 7.0 GHz	540B	572	Internal	± 1 dB	Narda♦ 3094	Krytar† D100‡	S-D* 457	S-D* 961-5	≤1.35:1	≥16.5 dB	≤ 17.7%
7.0 to 12.4 GHz	540B	572	Internal	± 1 dB	Narda♦ 3096	Krytar† D100‡	S-D* 457	S-D* 961-5	≤1.50:1	≥ 14 dB	≤ 20%
7.0-8.0 GHz	5000A	5014	1035	±0.7 dB	Narda♦ 3096	Krytar† D100‡	S-D* 457	S-D* 961-5			
8.0-12.4 GHz	5000A	5015	1035	±0.7 dB	Narda♦ 3096	Krytar† D100‡	S-D* 457	S-D* 961-5			
12.4 to 18.0 GHz	5000A	5016	1036	± 1 dB	Narda♦ 3096	Krytar† D100‡	S-D* 457	S-D* 961-5	≤1.60:1	≥12.8 dB	≤ 22%
12.4 to 18.0 GHz	540B	572	Internal	± 1 dB	Narda♦ 3096	Krytar† D100‡	S-D* 457	S-D* 961-5			

* Systron-Donner Corporation, Van Nuys, CA ♦ Narda Microwave Corporation, Plainview, L.I., NY † Krytar, Mountain View, CA
★ Or Internal Leveling ■ Or Internal Leveling with Option M2 Plug-in ▲ Appropriate Between-series RF Adapters Required ‡ Or Krytar D102 for Coupler with APC-7 Output

5-2.3 Calibrator Performance Check

The 30 MHz +10 dBm calibrator output has an accuracy of ±1.5% or .065 dB. It should be checked with a precision power meter having an accuracy better than ±0.5% or ±.02 dB and a return loss better than 30 dB. Any adapters or cables used must be low-loss. Note that RG 58/U cable has .02 dB/foot loss at 30 MHz. Other commonly available commercial power meters (such as the Hewlett Packard 431 and 432 Series) have an error or uncertainty of ±2% or ±.09 dB at 30 MHz and should not be used to check the calibrator output.

5-3. CALIBRATION

5-3.1 General

This paragraph contains instructions for calibrating the internal circuitry of the Model 4020A or 4021. Alignment is necessary when parts have been replaced, or when periodic performance checks reveal out-of-tolerance conditions.

5-3.2 Equipment Required for Calibration

Equipment used to calibrate the power meter must be of the highest quality and accuracy, and must have been recently calibrated by a qualified metrology laboratory. The significant characteristics and recommended models are listed in Table 5-4.

Table 5-4. Equipment Required for Calibration

ITEM INDEX	TYPE OF EQUIPMENT	SIGNIFICANT CHARACTERISTICS	RECOMMENDED MODELS
1	Precision DC Source	Accurate to ±0.1% or less for output voltages between 100 μV and 10 V. Ripple and noise must be at least 40 dB below the DC output level.	Systron-Donner M106A
2	DC Digital Voltmeter	Measures 10 mV with 10 μV resolution and .01% maximum error. Measures 12.6 V with 1 mV resolution and same accuracy.	Systron-Donner 7205
3	Precision Attenuators	Calibrated at 30 MHz to maximum error of ±.01 dB. Should contain one 10 dB and two 20 dB attenuators.	Systron-Donner 441A (for 4020A) or 447 (for 4021)
4	30 MHz RF Source	10 mW into 50 Ω. Spurious content and harmonics at least 50 dB below RF output level.	Systron-Donner 5000A with 5007 plug-in and 30 MHz bandpass filter
5	AC Thermal Transfer Standard	Maximum error 0.1% at 30 MHz. Must be designed for use at 1 V level.	Fluke A55* (see Note)
6	Precision Resistor	50 ±0.1 Ω, non-inductive	

* John Fluke Mfg. Co., Inc., Mountlake Terrace, WA

NOTE

If the input impedance of the transfer standard is not 50 Ω, shunt it with a metal film resistor such that a bridge measurement shows the total input impedance to be 50 ±.05 Ω. (It is helpful to build a fixture including a 50 Ω resistor and a connector so that the thermal standard is easily connected and disconnected from the source.)

5-3.3 Test Points and Adjustments

The test points used in the power meter will accept standard phone-tip size oscilloscope and voltmeter probes. Most probes with thread-on tips can be fitted with a tip of the appropriate size. The internal adjustment potentiometers are designed to be operated from the top with a fingertip, or from the side with a plastic screwdriver. Do not attempt to force a pot if physical resistance is met, and do not use lacquer, enamel, or any other sealer to hold the pots in place after adjustment.

Figure 5-2 shows the locations of the test points and adjustments accessible with the bottom cover of the power meter removed; these are described in Table 5-5.

Table 5-5. Calibration Test Point and Adjustment Summary

TEST POINT OR ADJUSTMENT	CIRCUIT	ACTION/FUNCTION
A2J1 (TP 21)	Compensation Amplifier Monitor	Measure between +TP 21 and -TP 23. Makes the initial adjustment of R9 so that the polarity of the reading changes as the input power goes through -27 dBm.
A2J2 (TP 22)	X2 Amplifier Monitor	Measure between TP 22 and TP 23. Monitors X2 Amplifier for proper operation.
A2J3 (TP 23)	Analog Signal Ground	Common point for all measurements to ground.
A2J4 (TP 24)	Input Amplifier Summing Junction	Measure between TP 24 and TP 23. Set A2R72 to obtain zero volts ±10 μV.
A2J5 (TP 25)	Log Transistor Emitter	Measure between TP 25 and TP 23. Monitors output of the log amplifier for proper operation (6.7 mV/dB).
A2J6 (TP 26)	Chopper Amplifier Output	Measure between TP 25 and TP 23. Monitors output of the chopper amplifier for proper operation.
A2J7 (TP 27)	Overn Current	Measure between +TP 27 and -TP 28. After initial warm-up, the voltage should be between 0.5 and 0.8 volts.

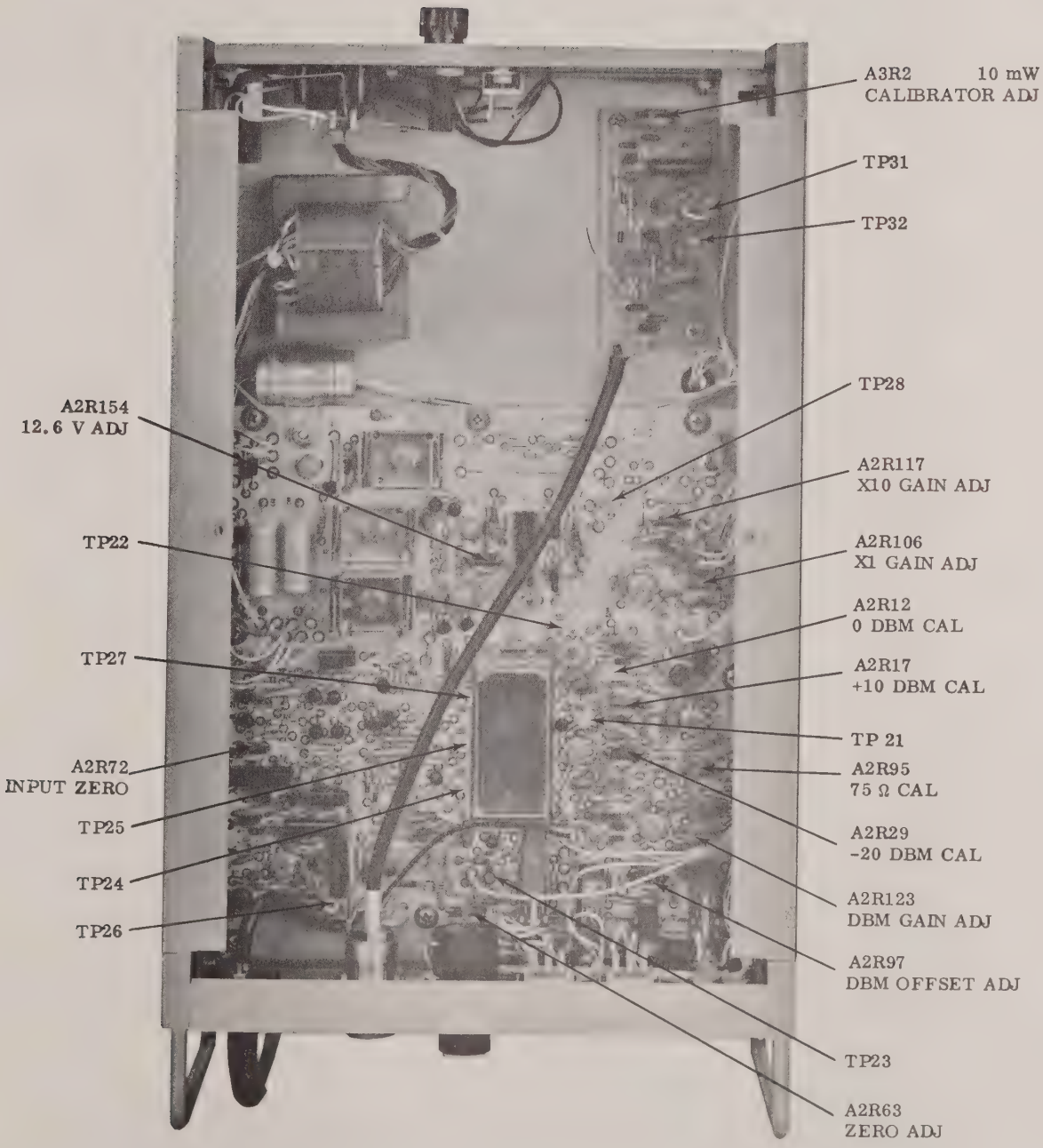


Figure 5-2. Test Points and Adjustments

Table 5-5. Calibration Test Point and Adjustment Summary (Continued)

TEST POINT OR ADJUSTMENT	CIRCUIT	ACTION/FUNCTION
A2J8 (TP 28)	-12.6 Volt Supply	Measure between TP 28 and TP23. The dc voltage should be -12.6 V ±10 mV.
A3J1 (TP 31)	Calibration Oscillator	Output of the calibrator before low-pass filter and 4 dB pad.
A3J2 (TP 32)	Not used	
A2R9	-20 dBm CAL	Used to set the input circuit for proper tracking at -20 dBm input level.
A2R12	0 dBm CAL	Used to set the input circuit for proper tracking at 0 dBm input level.
A2R17	+10 dBm CAL	Used to set the input circuit for proper tracking at +10 dBm.
A2R63	Zero CAL	Used to set the display to read zero with front panel zero control at mid-range
A2R72	Input Zero	Used to set the voltage at TP 24 to zero volts.
A2R95	75 Ω CAL	Used to compensate for the loss of 75 Ω input adapters.
A2R97	DBM Offset	Used to center the range of the DBM CAL screwdriver adjustment.
A2R106	X1 Gain	Used to set the output signal level to 10 dB per volt with the front panel OUTPUT switch set to 10 dB/V.
A2R117	X10 Gain	Used to set the output signal level to 1 dB per volt with the front panel OUTPUT switch set to 10 dB/V.
A2R123	DBM Gain	Used to set the signal level to the digital display so that one decade change in RF power causes the display to read 10 dB.
A2R154	-12.6 ADJ	Used to set the -12.6 V supply.
A3R2	10 mW Calibrator Adjust	Used to set the calibrator output to 10 mW.

5-3.4 Calibration Procedures

5-3.4.1 GENERAL. These power meters employ solid-state components exclusively. They are extremely reliable and generate very little heat. Consequently, there is little drift due to component aging, and adjustments to the instrument are rarely required. It is strongly recommended that if a measurement indicates that an adjustment is within the range indicated in the calibration procedure, that you do not attempt to "put it right on". It may well be that

variations in test equipment used to test the instrument could account for the difference, and that by setting an adjustment, other adjustments dependent upon a given setting will then be upset. In short, BE ABSOLUTELY SURE THAT AN ADJUSTMENT IS ACTUALLY REQUIRED BEFORE MAKING IT.

The calibration procedures will normally be performed only when circuit components are replaced, or when measurement errors attributable to out-of-tolerance performance are noted. Table 5-6 lists the applicable paragraphs and steps pertinent to calibration of circuitry within the power meter, or which must be performed under certain service conditions.

WARNING

YOU ARE EXPOSED TO LETHAL VOLTAGE LEVELS
WHEN ANY COVERS ARE REMOVED.

Table 5-6. Calibration Procedures Guide

CIRCUIT	ADJUSTMENTS AND CHECKS	
	PARAGRAPH	STEPS
Digital Display	5-3.4.2	1-4
-12.6 VDC Supply	5-3.4.3	2
+12.6 VDC Supply	5-3.4.3	2 and 3
+5.0 VDC Supply	5-3.4.3	2 and 4
Oven Control and Heater	5-3.4.4	1-11
Input Amplifier Log Circuit	5-3.4.4	2, 3, 4, 6.10
Computer Amplifier Log Circuit	5-3.4.4	5-8
Output Amplifier for Digital Display	5-3.4.4	3, 4
Output Amplifier for Analog Output	5-3.4.4	10
At -40 dBm does not read -40 but higher levels are correct	5-3.4.4	8, 9
After replacement of the detector element in the power head	5-3.4.4	2, 5-9
	Or the interim procedures in Paragraph 6-3.5.3, Section VI	
Calibrator	5-3.4.5	1-4

5-3.4.2 DISPLAY ZERO.

1. Remove the top cover of the power meter.

2. With the POWER switch set to the "off" position, connect a short test lead between pins 27 and 29 of the digital panel meter connector, J4. (Refer to Figure 5-3.)

CAUTION

DO NOT SHORT CIRCUIT ANY OTHER PINS.

3. Set the POWER switch to ON and allow the instrument to warm up for at least 10 minutes.

4. With a small jeweler's screwdriver, adjust the digital panel meter zero adjustment (item 18 of Figures 3-1 and 3-2) for a digital panel meter reading of 00.00.

5-3.4.3 POWER SUPPLIES.

1. Remove the bottom cover of the power meter.

2. Connect a voltmeter with at least 1 mV resolution between TP 28 and TP 23, the negative probe to TP 28 and the positive probe to TP 23. Turn on the power meter, and after a five-minute warmup, adjust R154, -12.6 V ADJUST, until the voltmeter reads 12.600 V ±5 mV.

3. Connect the negative voltmeter probe to TP 23. Touch the positive voltmeter probe to board pin 22 of A2. Verify a reading of 12.600 V ±10 mV.

4. Touch the positive voltmeter probe to board pin 31 of A2. Verify a reading of 5.00 V ±50 mV.

5. Turn the power off.

5-3.4.4 LOGARITHMIC MEASUREMENT CIRCUITS.

1. Connect the voltmeter between TP 27 and TP 28, the negative probe to TP 28 and the positive probe to TP 27. Turn on the instrument. At first the voltage should be ≈ 2.5 V; after one or two minutes, the voltage should drop to ≈ 0.5 V. After about five minutes, it should settle to a steady-state voltage of ≈ 0.6 V. Any steady-state value between 0.5 V and 0.8 V is satisfactory.

2. Connect the power head to an RF source of -30 dBm (item 4 of Table 5-4) and press the DBM 50 Ω button; use the attenuators (item 3) if necessary to maintain the input level ≤ 10 mW. Connect a voltmeter with at least 10 μV resolution (item 2) between TP 24 and TP 23. Connect the positive probe to either test point and the negative probe to the other; then adjust R72 INPUT ZERO so the voltmeter reads 0 V ±10 μV.

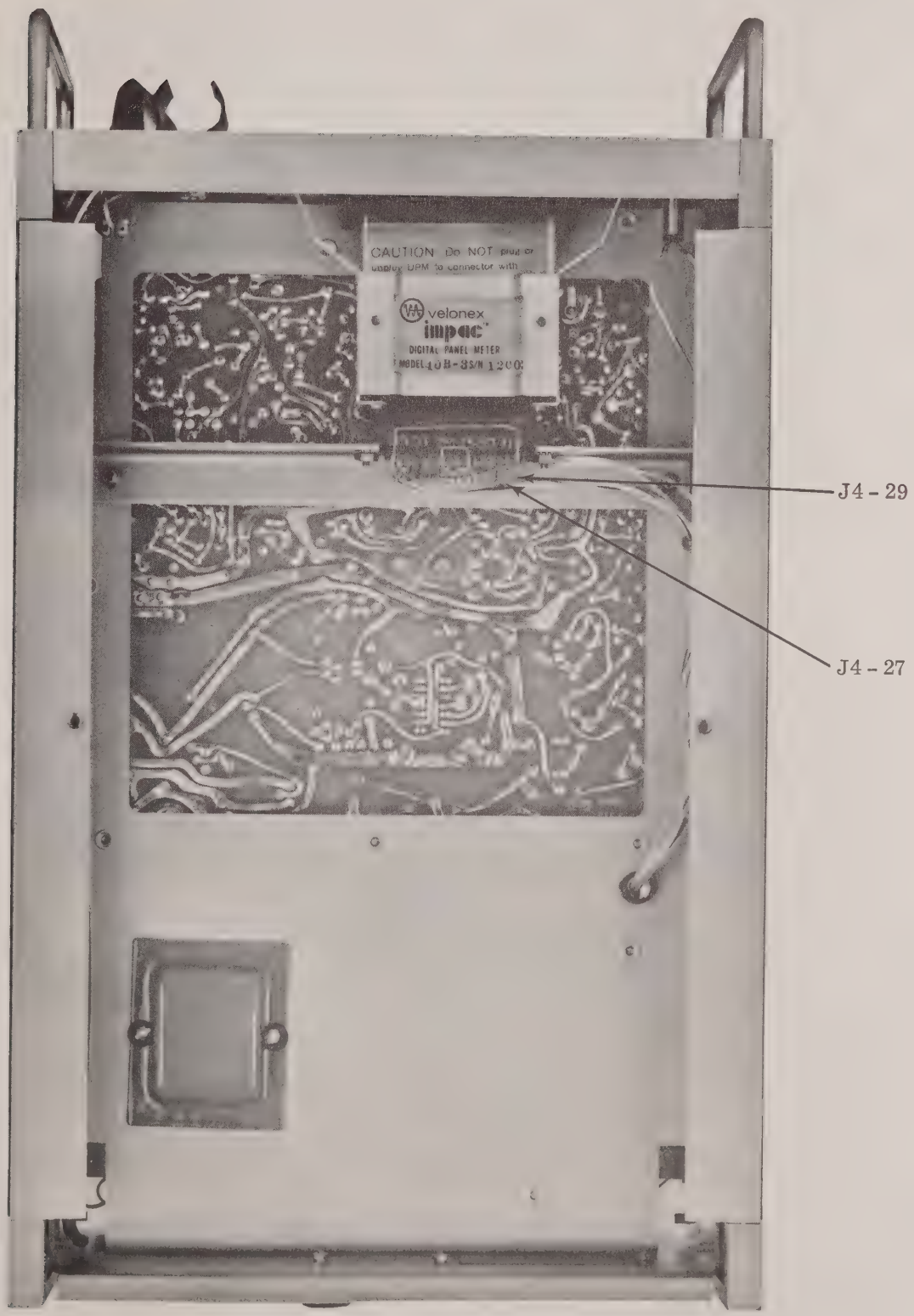


Figure 5-3. Digital Power Meter (Top View)

3. Connect the precision dc source (item 1 of Table 5-4) between TP 24 and TP 23. Connect the negative side to TP 24 and the positive side to TP 23. Connect the voltmeter between TP 25 and TP 23, the positive probe to TP 25 and the negative probe to TP 23. Press the DBM 50 Ω pushbutton, then set the power supply to 1 mV and measure voltage at TP 25. Set the power supply to 10 mV and measure the voltage at TP 25, then set the power supply to 100 mV and measure the voltage at TP 25. For the change in the input voltage of 1 mV to 10 mV, the voltage change at TP 25 should be 64 mV ±5 mV. The change in the voltage at TP 25 for the other changes in the input voltage should be within 1 mV of the change for 1 mV to 10 mV.

4. Connect the negative probe of the voltmeter to board Pin 4 and the positive probe of the voltmeter to TP 23. Set the power supply voltage to 1 mV and measure the output voltage. Now adjust R123 DBM GAIN until the change in the output is 2.00 V for the change of 1 mV to 100 mV in the input. After this adjustment is made, change the input voltage from 1 mV to 10 mV, 10 mV to 100 mV, and 100 mV to 1 V. Check to make sure that the change in the output for each decade change in the input is 1.000 V ±2 mV. Readjust R123 DBM GAIN to achieve these results. (In order to achieve these results for the change of 1 mV to 100 mV, the DC to ripple and noise ratio of the dc source must be at least 40 dB.)

5. Connect the power head to the RF source (item 4 of Table 5-4) through 30 dB of attenuation. With the RF source off, press the ZERO button and zero the instrument. Then press the DBM 50 Ω button and set the RF input to -30 dBm. Verify the amplitude is correct with item 5. Connect a voltmeter between TP 21 and TP 23. The polarity will change, so the voltmeter can be connected either way as long as an on-scale reading is obtained. Adjust R9 -10 DBM CAL so the voltage at TP 21 just goes negative. Increase the RF input amplitude by 3 or 4 dB and verify the voltage at TP 21 becomes positive.

6. Using item 5 of Table 5-4, set the RF input to -30 dBm and set the front-panel DBM CAL adjust to the center of rotation. Adjust R97 DBM OFFSET so that the display reads -30.00.

7. Set the RF input to 0 dBm and adjust R12 DBM CAL until the display reads 00.00. Then set the RF input to +10 dBm. Note the reading on the display. If it is greater than +10, adjust R17 +10 DBM CAL until the reading is less than +10 by about as much as it was greater than +10. If it is less than +10, adjust R17 +10 DBM CAL until the reading is greater than +10 by about as much as it was less than +10. Then reset the RF input to 0 dBm and readjust R12 0 DBM CAL until the display reads 00.00. This procedure should be continued until a correct reading at 0 dBm and +10 dBm is obtained on the display.

8. Set the RF input to -40 dBm and adjust the front-panel ZERO control so the display reads -40.00. Set the RF input to -30 dBm and check that the reading is still -30.00. If it is not, set the front-panel DBM CAL adjust so the display reads -10.00. Set the RF input to -30 dBm and measure the voltage between TP 21 and TP 23. Make sure that at -30 dBm the voltage is negative; if it is not, readjust R9 -10 DBM CAL until the voltage just goes negative.

9. Turn off the RF, press the ZERO button and adjust R63 ZERO CAL until the display reads 00.00.

10. Connect the digital voltmeter (item 1 of Table 5-4) to the OUTPUT connector. The digital voltmeter should be set to its 10 volt range. Connect the power detector to the RF source and set the RF source for 0 dBm. Press the DBM 50 Ω button and set the OUTPUT switch to 10 DB/V and the GROUNDING switch to INT. Adjust the front-panel OFFSET so that the digital voltmeter agrees with the instrument display. Now change the RF input to -20 dBm. Adjust R106 X1 GAIN until the voltmeter agrees with the instrument display. Reset the RF input to 0 dBm and the OUTPUT LEVEL switch to 1 DB/V. Adjust the OFFSET control until the digital voltmeter reads zero. Change the RF input by 5 dB. Adjust R117 X10 GAIN until the digital voltmeter reads 5.00 V ±10 mV.

11. Press the DBM 50 Ω button and the front-panel DBM CAL adjust so that the display reads 00.00. Now, press the DBM 75 Ω button. The display then will indicate the insertion loss of the 75 Ω to 50 Ω adapter. If the reading does not match the loss of the adapter, adjust R95 75 Ω CAL until the display is reading the right value for the adapter that will be used with the instrument.

5-3.4.5 CALIBRATOR.

1. Set the precision power supply (item 5 of Table 5-4) to 1.414 V. Connect a precision 50 Ω ±0.1% resistor (item 6) from the positive output of the supply to the center pin of a male Type N connector (4020A) or to the center conductor of a Type APC-7 connector (4021). Connect the outer shell of the connector to the negative output of the supply.

2. Connect the thermal transfer standard to the output connector. Turn the positive output of the precision supply on, and read the output of the thermal transfer standard (to a precision of at least 0.1% on the digital voltmeter). Reverse the polarity of the supply and repeat the reading. Record the average of the two dc output voltages from the transfer standard.

3. Connect the transfer standard to the power meter CAL OUT connector. Press the DBM CAL button, and adjust A3R2 so that the transfer standard has the same output as the average reading obtained in step 2.

4. Reconnect the transfer standard to the supply through the 50 Ω resistor and check to see that the same output as obtained in step 2 is measured. This last step is important, as transfer standards drift with changes in ambient temperature. If there is a significant difference in the readings before and after the calibrator measurement, repeat the procedure.

SECTION VI

MAINTENANCE

6-1. GENERAL

This section contains instructions for routine servicing and cleaning of the instrument, for the isolation and repair of malfunctioning circuits and components, and replacement instructions for the microwave crystal detector element in the power head. An interim adjustment procedure for field calibration of the power meter after detector replacement follows the replacement procedure.

6-2. ROUTINE MAINTENANCE

The power meter in normal laboratory environments requires only brief annual service. When operated under more severe conditions (dusty or chemically-contaminated environments), more frequency service is required. All routine maintenance and cleaning should be completed prior to performing the calibration procedures in Section 5:

1. Turn the power off, then unplug the power connector.

2. Remove the top cover by removing two screws and lifting the cover off. The bottom cover may be removed in the same manner.

3. Remove any accumulated dust or other foreign material with a soft brush and low-pressure dry air.

4. Inspect the unit carefully for loose screws, nuts, etc.; tighten any hardware requiring it. Check all wire lead connectors to make sure they are properly seated on their board pins.

5. Check the unit carefully for damaged or overheated components, pieces of solder or wire, frayed wire insulation, etc.

6. Replace the covers.

7. Perform the checks detailed in Paragraph 5-2, Section V.

8. Remove any metal particles or other foreign material from the power head and calibrator connectors, using a Q-Tip® saturated with isopropyl alcohol.

IMPORTANT

Do not use aromatic or chlorinated hydrocarbons, esters, ethers, terpenes, higher alcohols, ketones, or ether-alcohols such as benzene, toluene, turpentine, dioxane, gasoline, cellosolve acetate, or carbon tetrachloride. Keep exposure of the connector parts to the alcohol and its vapors as brief as possible.

6-3. CORRECTIVE MAINTENANCE

6-3.1 Initial Checks

In the event of apparent malfunction of the Power Meter, refer to Table 6-1.

Table 6-1. Malfunction Checklist

MALFUNCTION	POSSIBLE CAUSE
No Digital Display	Check Power Switch Check Power Cord Check Fuse F1 on Rear Panel Check Power Source Check 115 V/230 V Switch Check Internal Power Supplies Check Panel Meter
Display on, but no reading	Check Input Signal Check Detector Check that DBM 50 Ω or DBM 75 Ω button is in
No Calibrator Output	Check that DBM CAL button is in Check Output with Oscilloscope or other Power Meter
Display Unstable	Check Input Signal for Excess AM Check Input Signal for Swept Mode instead of CW Mode Check Connections of Probe and Cables Check for Ground Loops
Display Reading Incorrect but Analog Voltage at OUTPUT Connector OK	Check Digital Display
Digital Display Wrong at Low Levels	Check for Short Circuit at OUTPUT Check for Ground Loops Adjust ZERO Control Check Chopper Amplifier
Digital Display Wrong at High Levels	Check Computer Amplifier
Digital Display Wrong at All Levels	Check Detector Diode for Damage Unit Needs Calibration Check Internal Ovens
Analog Output Incorrect	Output Saturated. Check LEVEL Switch

6-3.2 Trouble Isolation

The process of trouble isolation requires successive isolation of the cause of a malfunction to succeedingly smaller parts of the circuit. The circuit description in Section IV should help with the detailed analysis of troubles within each circuit. In addition, the following general procedure should be followed. As an aid to circuit tracing, Figure 6-1 shows the basing diagrams and pin callouts of several different semiconductor devices used in the unit.

CAUTION

BE VERY CAREFUL WITH OSCILLOSCOPE AND VOLTMETER PROBES TO AVOID ACCIDENTALLY BRIDGING TWO POINTS OR SHORTING A COMPONENT LEAD OR WIR TO GROUND. LACK OF ADEQUATE CARE WITH SEMICONDUCTOR CIRCUITS CAN TURN RELATIVELY MINOR PROBLEMS INTO COSTLY REPAIRS.

1. If there is power to the instrument but the display is incorrect or absent, check the OUTPUT connector for proper operation. If operation is normal, the digital display is suspect. If operation is abnormal, first check the detector input, found on A2 pin 18. With +10 dBm applied to the detector (connect the detector to CAL OUTPUT and press the DBM CAL button), there should be approximately 0.5 VDC at pin 18. With no power applied, the voltage should drop to zero. Be sure that the calibrator is working; a quick check can be made with a 50 MHz oscilloscope. The peak-to-peak open circuit voltage at the CAL OUT connector should be approximately 4 V. If a gross error is found, proceed to step 2, then directly to 9. If not, proceed to 2 and continue.

2. Check the operation of the power supplies. Refer to the schematic diagram in Section VIII. Measure from A2 pins 20, 21, and 30 to ground (TP 23). Voltages should be +12.6, -12.6, and +5.0 VDC. Ripple should be less than 2 mV. If these voltages are present, proceed to 3. If these voltages are not present or are low, check each supply for an overload. If the trouble is in the supply, first get the -12.6 V supply operating, as the positive supplies are dependent upon it. If oscillations are present, check C68, C70, or C72.

3. Turn the power off and allow the instrument to stand for 5 to 10 minutes. Connect the power head to the CAL OUT connector and press the DBM CAL button. Now turn the power on and observe the display. The reading should start out very much above +10 dBm and settle to the correct reading after a few minutes. If it does not change at all, or overshoots and settles well below +10, check the oven circuits using the procedure of 5-3.4.4 step 1. If operation is normal, proceed to 4. If operation is not as described in 5-3.4.4 step 1, check Q23; initially the collector voltage should be about -5, dropping to -11.3 after warmup. If it is not open or shorted, check Q34.

4. Check the operation of the input amplifier using the procedure of 5-3.4.4 step 3. If operation is normal at low levels, proceed to step 6. If the

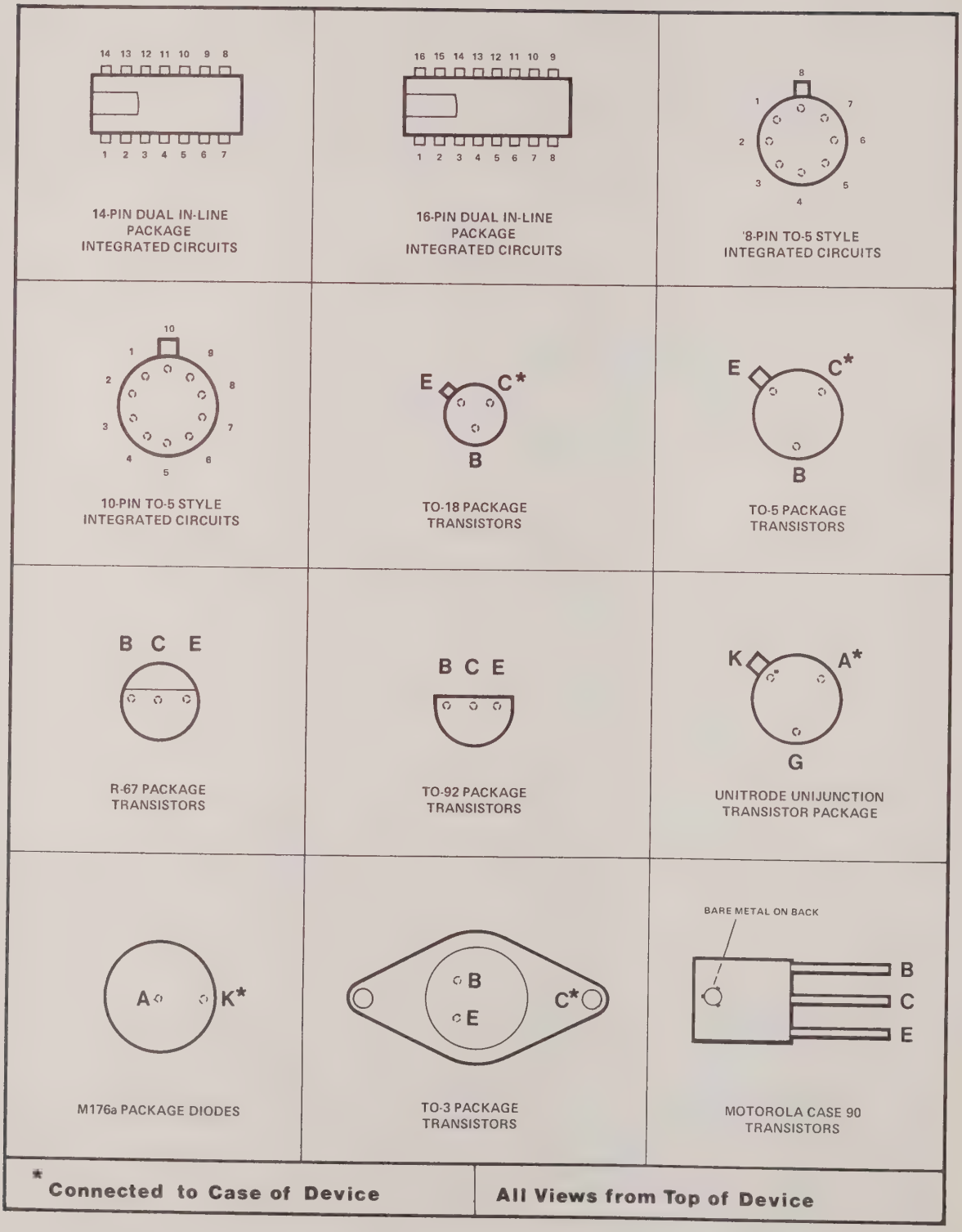


Figure 6-1. Integrated Circuit and Semiconductor Basing Diagram

operation is normal at all levels, proceed to step 7. If not, first check the operation of the chopper amplifier, as the input amplifier depends upon it for proper operation. Connect a dc voltmeter with at least 1 mV full-scale sensitivity between TP 24 and TP 23; by adjusting A2R72, it should be possible to bring the reading to zero. If not, connect an oscilloscope probe to TP 26; the ground lead should go to TP 23. Compare the waveform obtained thereby with the one shown in Figure 6-2A. Short either end of A2R67 to ground and check again--the waveform should change breifly, then settle to its previous appearance. In any case, with A2R67 shorted, the waveform should appear normal; if not, trouble in the chopper amplifier is indicated, First, check the square wave drive signals applied to the two input FET's, Q18 and Q19, and the drive to the demodulator Q21 base. See Figures 6-2B and 6-2C.

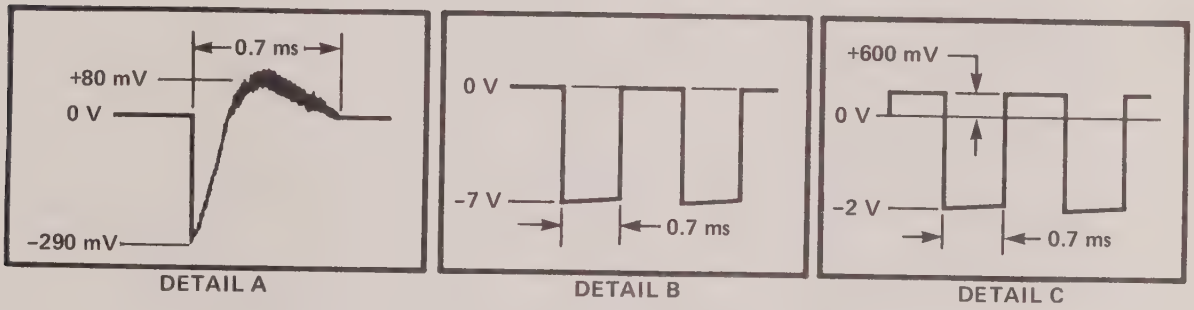


Figure 6-2. Input Amplifier A2 Waveforms

5. If the chopper operation is normal, check the input amplifier by measuring the unbalance at the collectors of Q12, Q14, and Q15. If there is a defective component along the string of differential amplifiers, the unbalance will at some point reverse, indicating that the signal is not getting through.

6. Check the computer amplifier using the procedure of 5-3.4.4 step 5. If this procedure can be performed, compare the voltage change at TP 21 and TP 22 as the input power is varied between -10 dBm and 0 dBm. The change at TP 22 should be very close to twice the change at TP 21.

7. Check the operation of the X15 amplifier. Connect a dc voltmeter to pin 6 of U4. At zero dBm input power, the voltage there should be zero. It should change by 1 V for each 10 dB change in RF power. If not, be sure the conditions of 5-3.4.4 steps 3 and 4 are met. If they are, trouble in U4 or the associated circuits may be indicated. If operation is normal, proceed to step 8.

8. Check U5 pin 6. Voltage should be zero at 0 dBm input. The voltage should change by 1 V for each 10 dB input change.

9. If the output of the calibrator is too low or not present at all, measure the voltage at the collector of Q23 on A3. If the voltage is between 0.6 and 4 V, check Q25. If not, look for malfunctions at Q23, Q24, or their associated

components. If the calibrator output is too high, check CR11 or CR12, or Q24. Defective capacitors C46, C47, C51, or C52 can cause "squeezing" of the oscillation.

10. If the digital display is found to be at fault, it must be replaced entirely; it is a sealed, non-repairable assembly.

6-3.3 Printed Circuit Board Repair

Repair of the power meter is limited to location and replacement of defective components and sealed subassemblies. To avoid damage to the printed circuit cards and to precision components, solder or remove components only with a low-power (25 to 50 W, 500 to 700°F) soldering iron. Do not use soldering guns or large irons. Use only 60-40 or 63-37 rosin core solder. To remove integrated circuit operational amplifiers, use a special iron tip that unsolders all leads at the same time (available from Ungar and other manufacturers). Remove excess solder from circuit card holes with a vacuum device.

6-3.4 Contact Pin Replacement (Model 4021 Only)

Through wear or damage, the APC-7 inner conductor contact may need replacement. Need for replacement may be manifested as increased input VSWR, particularly in the 12.4 to 18 GHz band. This contact is a small, four-pronged collet which snaps into a recess in the center conductor (refer to Figure 6-3). This contact is normally held in by the spring action of the four prongs. Examine this contact to determine if it needs replacement. DO NOT REMOVE THIS CONTACT FOR INSPECTION (it may be damaged by removal). The contact should be free of burrs or wear, and the prongs should be equally spaced. If the contact is removed, do NOT re-use it (it may be damaged by removal). This contact is Amphenol part number 131-1054 or Systron-Donner part number 108151. If the contact needs replacement and a new contact is available, proceed as follows:

1. Place the power head or power meter so the connector faces down.

2. Tap the connector lightly; the contact should now protrude slightly.

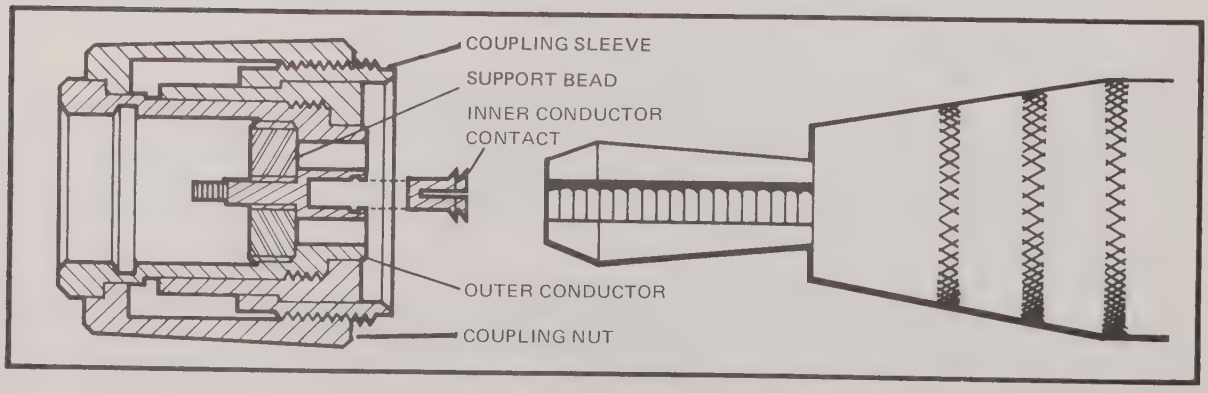


Figure 6-3. APC-7 Connector

3. Amphenol replacement kit 131-2025 contains the extraction, insertion, and disassembly tools used for APC-7 connector service. If the Amphenol tools and instructions are not available, proceed as in steps 4 through 6.

4. Grasp the contact with an ordinary draftsman's mechanical pencil (the end of the jaws may have to be filed to get a good grasp).

5. Allow the jaws of the pencil to close and pull straight away from the connector without twisting. The contact should come with the pencil. If not, repeat the process. Discard the contact to prevent re-use.

6. Snap in a new contact by pushing it lightly into place.

6-3.5 Detector Diode Replacement

The microwave diode in the detector head can be damaged by dropping, static electricity discharges, or excessive power. The vast majority of damaged detectors have been subjected to excessive power. Unless the following precautions are observed, a new detector can be rendered useless quite easily:

1. Before installing a detector element into the detector mount, discharge any static voltages that may exist between yourself and the mount by touching the mount.

2. When handing a detector element to another person, discharge static voltage by touching hands before passing the element.

3. Do not use ohmmeters to check the detector element, since the voltages and currents available from most such meters can easily damage the sensitive diodes used in these elements.

6-3.5.1 MODEL 4020A. Model 4020A power meters (1 MHz to 12.4 GHz, precision Type N connector) require replacement detector kit PM12220. This kit contains a new detector element, capsule spacer, capacitive washer, and calibration label. In some cases, a kit contains a new metal film resistor to replace A2R41 on the input amplifier board. Refer to Figure 6-4 for the location of the various detector components.

To replace the detector:

1. Unscrew the cap assembly from the probe body. In separating these parts, use two pairs of pliers with plastic jaws or protect the parts with heavy paper or tape. To prevent undue strain on the cable, hold the cap assembly stationary and turn the body section to disassemble.

NOTE

Do not attempt to disassemble the cap assembly; it is a sealed unit containing sensitive temperature compensation components. If the cap or cable assembly is damaged, replace both.

2. Use a spanner wrench or long-nosed pliers to unscrew the slotted metal clamp.

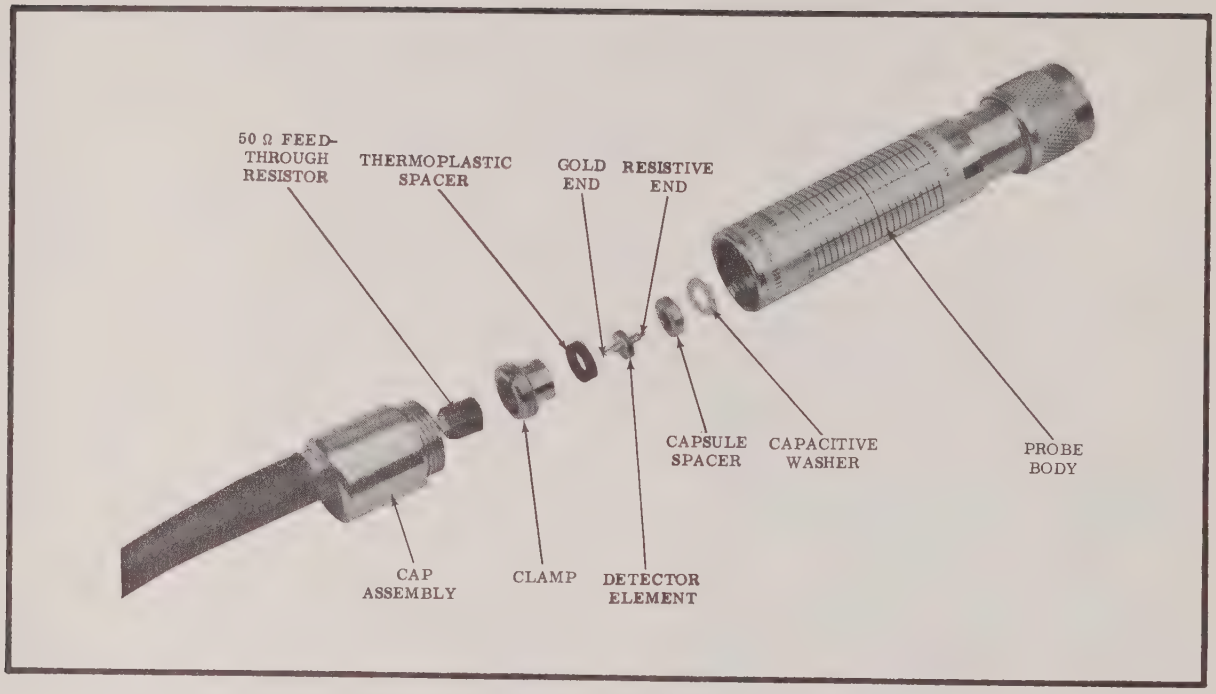


Figure 6-4. 4020A Power Head Assembly

3. Carefully remove the black thermoplastic spacer.

4. Remove the detector, capsule spacer, and capacitive washer.

5. Install the new capacitive washer, capsule spacer, and detector element in that order. Note that the polyiron side of the capsule spacer should be against the capacitive washer. Insert the resistive end (dark brown colored) of the detector element into the center contact inside the body.

CAUTION

WHEN INSERTING THE DETECTOR ELEMENT, DO NOT FORCE THE TIP INTO THE CENTER CONDUCTOR IN THE BODY. THE FINGERS OF THE CENTER CONDUCTOR MAY BE DAMAGED.

6. Replace the plastic spacer, indented side out.

7. Replace and tighten the clamp.

8. Replace the cap assembly and tighten firmly.

9. A metal film resistor may be furnished with the detector replacement kit to replace A2R41 (input resistor) located in the front of the A2 PC Board Assembly. Check the value of A2R41 in the unit and change it only if the value of the replacement differs from the existing one in the unit.

10. Install the new calibration label over the existing one on the probe body.

11. After replacement of the detector element, the meter must be calibrated in accordance with the procedures in Section V. If this is not immediately possible, and the power meter must be used, perform the interim adjustment procedures in Paragraph 6-3.5.3.

6-3.5.2 MODEL 4021. Model 4021 power meters (10 MHz to 18 GHz, precision 7-mm connector) require detector kit PM12372. In some cases, a kit contains a new metal film resistor to replace A2R41 on the input amplifier board. Refer to Figure 6-5 for the location of the various detector components.

To replace the detector:

1. Unscrew the connector from the probe body. It is not necessary to separate the cap assembly from the probe body. In separating these parts, use two pairs of pliers with plastic jaws or protect the parts with heavy paper or tape.

2. Remove the detector, capsule spacer, and capacitive washer.

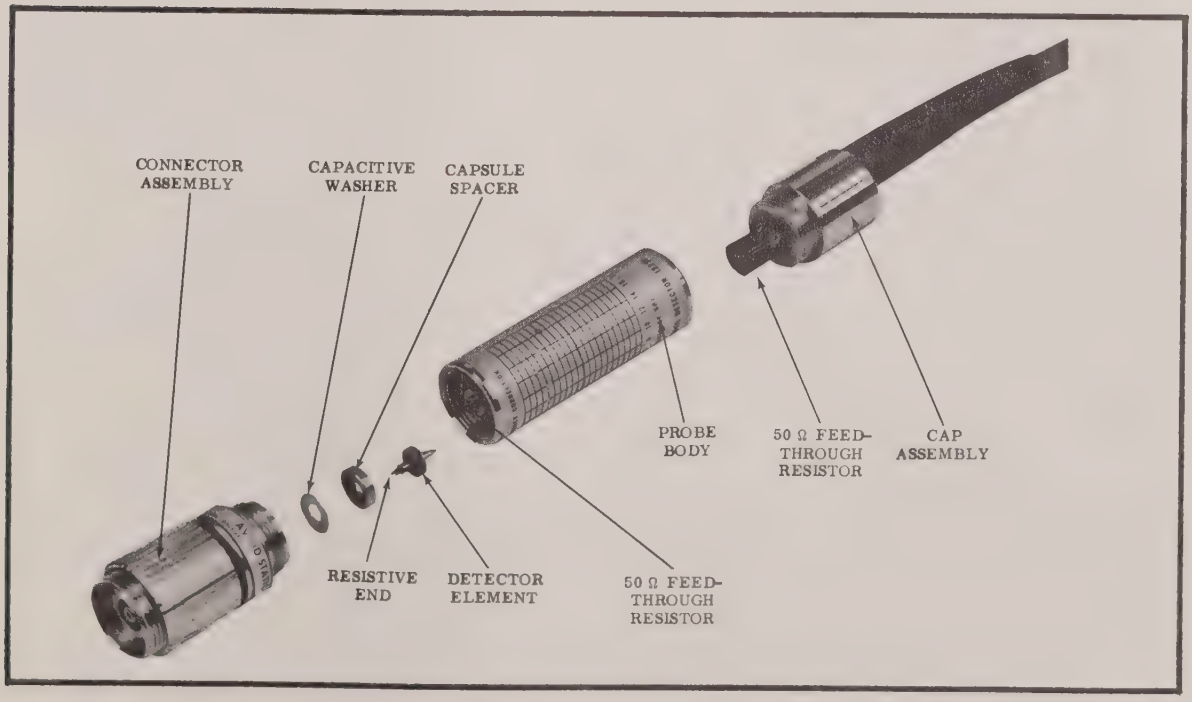


Figure 6-5. 4021 Power Head Assembly

3. Install a new capacitive washer, capsule spacer, and detector element in that order. Note that the polyiron side of the capsule spacer should be against the capacitive washer. Insert the resistive end (dark brown colored) of the detector element into the center contact inside the body.

CAUTION

WHEN INSERTING THE DETECTOR ELEMENT, DO NOT FORCE THE TIP INTO THE CENTER CONDUCTOR IN THE BODY. THE FINGERS OF THE CENTER CONDUCTOR MAY BE DAMAGED.

4. Re-assemble the connector and body assemblies; tighten firmly.

5. A metal film resistor may be furnished with the detector replacement kit to replace A2R41 (input resistor) located in the front of the A2 PC Board Assembly. Check the value of A2R41 in the unit and change it only if the value of the replacement differs from the existing one in the unit.

6. Install the new calibration label over the existing one on the probe body.

7. After replacement of the detector element, the meter must be calibrated in accordance with the procedures in Section V. If this is not immediately possible, and the power meter must be used, perform the interim adjustment procedures in Paragraph 6-3.5.3.

6-3.5.3 INTERIM ADJUSTMENT PROCEDURE. This adjustment procedure can be used after replacement of the detector element if it is not immediately possible to use the calibration procedures in Section V. This procedure requires the use of the 50 Ω attenuators listed in Table 6-2; the attenuators must include a previously-determined chart of correction factors for 30 MHz operation to the tolerances listed in the table.

Table 6-2. Attenuators Required for Interim Adjustment

POWER METER	VALUE (DB)	TOLERANCE (DB)	EXAMPLE	QUANTITY
4020A	10	±0.1	Systron-Donner 441A	1
4020A	20	±0.1	Systron-Donner 441A	2
4021	10	±0.1	Systron-Donner 447	1
4021	20	±0.1	Systron-Donner 447	2

The ±0.1 dB maximum error listed in Table 6-2 will yeild power meter calibration accurate to ±0.1 dB; the more accurate the attenuator, the better the results of this procedure. The interim adjustment procedure is detailed below and condensed in Table 6-3.

1. Remove the bottom cover of the power meter.

1. Remove the bottom cover of the power meter.

WARNING

LETHAL VOLTAGES ARE PRESENT WHENEVER A COVER IS REMOVED.

2. Turn on the instrument power. Let the unit stabilize for 10 to 20 minutes.

3. Connect the power head to the CAL OUT connector. Depress the ZERO switch. Adjust the front-panel ZERO control to obtain a power meter reading of ±00.00. If no setting of the ZERO control gives this reading, set the control to mid-range and adjust A2R63 ZERO CAL (see Figure 5-2) for 00.00 power meter reading.

4. Depress the DBM CAL switch. Connect a dc voltmeter or dc oscilloscope with at least 25 kΩ input impedance between terminal 5 on A2 and terminal 2 (floating ground). Adjust front-panel DBM CAL control for a voltage reading less than ±0.5 V. Disregard the power meter reading when making this adjustment. This sets DBM CAL control to mid-range.

5. Depress the ZERO switch and adjust the front-panel trimmer ZERO for ±00.00 reading.

NOTE

The following steps require the use of calibrated attenuators. Use the exact calibrated value at 30 MHz for each attenuator to determine the correct power meter readings in each of the following steps.

6. Depress the DBM CAL switch. Insert a 50 Ω, 40 dB attenuator between the power head and CAL OUT connector as shown in Figure 6-6. Adjust A2R97 DBM OFFSET to obtain a power meter reading of -30.0 ±0.5 dBm.

7. Adjust the front-panel DBM CAL trimmer for a power meter reading of -30.00 dBm.

8. Insert a precision 50 Ω, 10 dB attenuator as shown in Figure 6-6. Check for a power meter reading of ±00.00 dBm. If necessary, adjust A2R12 0 DBM CAL to obtain this reading.

9. Remove the attenuators and reconnect the power head to the CAL OUT connector. Observe the power meter reading. If it is below +10.00 dBm, adjust A2R17 +10 DBM CAL to give a reading above +10.00 dBm by an amount that is 5 times greater than the difference between the observed reading and +10.00 dBm. If the reading is above +10.00 dBm, adjust A2R17 +10 DBM CAL to give a reading that is below +10.00 dBm by an amount that is 5 times greater than the difference.

10. Repeat steps 8 and 9 until the correct power meter readings are obtained.

11. Insert a 20 dB, 50 Ω attenuator and check for a power meter reading of -10.00 dBm. Readjust A2R9 -20 DBM CAL if necessary to obtain this reading.

12. Repeat steps 5 through 11 at least twice until correct power meter readings are obtained at each step.

13. This concludes the interim adjustment procedure. As soon as possible, return the unit to a standards laboratory for calibration in accordance with Section V. Mark the instrument so that it is known that a detector element was replaced.

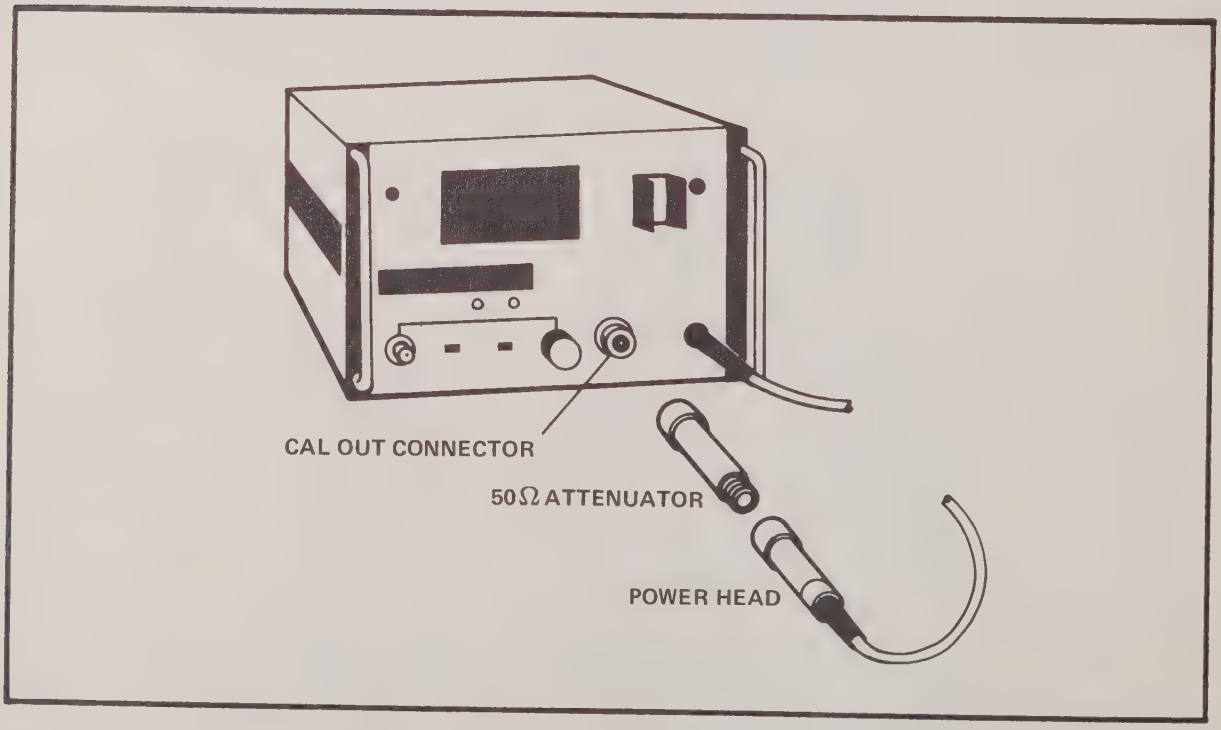


Figure 6-6. Setup for Interim Adjustment Procedure

Table 6-3. Interim Adjustment Summary

STEP	DEPRESS SWITCH	50 Ω ATTENUATORS VALUE (DB)	CORRECT READING	PANEL ADJUST-MENT	INTERNAL ADJUST-MENT
3	ZERO	0	±00.00	ZERO	A2R63 ZERO CAL
4	DBM CAL	Adjust panel DBM CAL control for less than ±0.5 V between terminals 5 and 2 on A2			None
5	ZERO	0	±00.00	ZERO	None
6	DBM CAL	40.00	-30.0 ±0.5 dBm	None	A2R97 DBM OFFSET
7	DBM CAL	40.00	-30.00 dBm	DBM CAL	None
8	DBM CAL	10.00	00.00 dBm	None	A2R12 0 DBM CAL
9	DBM CAL	0	+10.00 dBm	None	A2R17 +10 DBM CAL (overcom-pensate by 5X error)
10	Repeat steps 8 and 9 until correct readings are obtained				
11	DBM CAL	20.00	-10.00 dBm	None	A2R9 -20 DBM CAL
12	Repeat steps 5 through 11 at least twice until correct readings are obtained at each step				

SECTION VII

REPLACEABLE PARTS LISTS

7-1. INTRODUCTION

This section contains replaceable parts lists for the Model 4020A and the Model 4021 Digital Power Meters.

7-2. REPLACEMENT PARTS

The majority of the electronic parts used in the power meter are standard distributor items, and should be available locally. To order special replacement parts and parts which are not otherwise obtainable, write to Systron Donner Corporation at the address shown on the warranty and service card at the front of this manual, contact your local Systron Donner Service Center, or contact your local Scientific Devices office.

Be sure to include the model number (4020A or 4021) and serial number of the unit for which parts are required. Please order by Systron Donner part number; also include the reference designator where applicable.

7-3. EXPLANATION OF COLUMNS

FIG. NO. This column references the figure number in which the part can be located.

REFERENCE DESIGNATION. Parts are listed in sequence by reference designation and may be located on the schematic diagram or other referenced figure by this designator.

SYSTRON DONNER PART NUMBER. All standard parts manufactured by Systron Donner or manufactured to Systron Donner specifications are listed in this column, but not in the MFR'S PART NUMBER column. All other purchased parts which have been assigned Systron Donner part numbers are also listed in this column. These part numbers must be used when ordering parts.

MFR'S PART NUMBER. Commercially-available parts not manufactured by Systron Donner or to Systron Donner specifications are listed in this column. Insofar as possible, these part numbers are complete. For best results, always include a complete part description as well as the listed manufacturer's part number when ordering replacement parts from manufacturers or distributors.

MFR. The five-digit Federal Manufacturers Codes, as listed in Cataloging Handbooks H4-1 and H4-2, are listed in this column. These codes and corresponding manufacturers are listed in Paragraph 7-4.

DESCRIPTION. Descriptions of component parts of subassemblies are indented to indicate the parts comprising each subassembly.

7-4. MANUFACTURER'S CODES

CODE	NAME
01121	Allen Bradley Co. Milwaukee, WI

CODE	NAME
01220	Systron-Donner Corporation Microwave Division Van Nuys, CA
01295	Texas Instruments, Inc. Van Nuys, CA
03494	General Electric Co. Schenectady, NY
04618	AMP Special Industries Division of AMP, Inc. Paoli, PA
05464	Industrial Electronic Engineers, Inc. Van Nuys, CA
07263	Fairchild Semiconductor Mountain View, CA
09052	SAFT America, Inc. Metuchen, NJ
09353	C & K Components, Inc. Watertown, MA
12060	Diodes, Inc. Chatsworth, CA
12065	Transitron Electronic Corporation East Boston, MA
12954	Siemens Corporation (formerly Dickson) Components Group Scottsdale, AZ
14674	Corning Glass Works Electronic Product Division Corning, NY
15818	Teledyne Semiconductor Mountain View, CA
16428	Belden Corporation Electronic Division Richmond, IN
18714	RCA Solid State Division Findlay, OH
21030	Beckman Instruments, Inc. Helipot Division Fullerton, CA
24931	Specialty Connector Co., Inc. Indianpolis, IN
25088	Siemens Corporation Iselin, NJ

CODE	NAME
27014	National Semiconductor Corporation Santa Clara, CA
28480	Hewlett Packard Co. Palo Alto, CA
30698	VID Metal Products, Inc. Minneapolis, MN
32570	Velonex Display Products Division of Varian, Inc. Santa Clara, CA
34165	Inter-Market, Inc. Glenview, IL
52542	Systron-Donner Corporation Concord, CA
56289	Sprague Products Co. North Adams, MA
71785	TRW/Cinch Elk Grove Village, IL
72982	Erie Technological Products Erie, PA
74970	E. F. Johnson Co. Waseca, MN
75915	Littelfuse, Inc. Des Plaines, IL
79727	C-W Industries Warminster, PA
80294	Bournes, Inc. Riverside, CA
82389	Switchcraft, Inc. Chicago, IL
89709	Bunker Ramo Corporation Connector Division (formerly Amphenol RF Division) Bradview, IL
91418	Radio Materials Co. Division of P. R. Mallory Chicago, IL
99392	Mepco/Electra, Inc. Oakland, CA
99800	Delevan Electronics Corporation East Aurora, NY

FIG. NO.	REFERENCE DESIGNATION	SYSTRON-DONNER PART NUMBER	MFR'S PART NUMBER	MFR.	DESCRIPTION
8-1	A1	PM13332	40B-3	32570	PANEL METER, Digital, 4 digit with polarity indicator
8-2	A2	PM11670-2		01220	BOARD ASSY - INPUT AMPLIFIER Consisting of:
	A2C1	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C2	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C3	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C4	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C5	PM10000-1	5GA-T10	56289	CAPACITOR, Ceramic, 100 pF ±20%, 1000 V
	A2C6	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C7	PM10000-4	5GA-T10	56289	CAPACITOR, Ceramic, .001 μF ±20%, 1000 V
	A2C8	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C9	PM10007-4	75F1R2A103	03494	CAPACITOR, Mylar, .01 μF ±10%, 200 V
	A2C10	PM10001-5	10TCC-Q33	56289	CAPACITOR, Ceramic, 33 pF ±5%, 1000 V
	A2C11				Not used
	A2C12	PM10000-10	TA0.1MF	91418	CAPACITOR, Ceramic, 0.1 μF +80% -20%, 100 V
	A2C13	PM10000-10	TA0.1MF	91418	CAPACITOR, Ceramic, 0.1 μF +80% -20%, 100 V
	A2C14				Not used
	A2C15	PM10000-8	5GAS-S20	56289	CAPACITOR, Ceramic, .022 μF ±20%, 500 V
	A2C16	PM11173-1	196D337X0006TE4	56289	CAPACITOR, Tantalum, 330 μF ±20%, 6 V
	A2C17	PM10000-10	TA0.1MF	91418	CAPACITOR, Ceramic, 0.1 μF +80% -20%, 100 V
	A2C18	PM10001-3	10TCC-Q10	56289	CAPACITOR, Ceramic, 10 pF ±5%, 1000 V
	A2C19	PM10000-10	TA0.1MF	91418	CAPACITOR, Ceramic, 0.1 μF +80% -20%, 100 V
	A2C20	PM10000-4	5GA-T10	56289	CAPACITOR, Ceramic, .001 μF ±20%, 1000 V
	A2C21	PM10007-1	75F1R2A102	03494	CAPACITOR, Mylar, .001 μF ±20%, 200 V
	A2C22	PM10007-7	75F3R2A104	03494	CAPACITOR, Mylar, 0.1 μF ±10%, 200 V
	A2C23	PM10001-7	10TCC-T10	56289	CAPACITOR, Ceramic, 100 pF ±5%, 1000 V
	A2C24	PM10007-7	75F3R2A104	03494	CAPACITOR, Mylar, 0.1 μF ±10%, 200 V
	A2C25	PM10000-10	TA0.1MF	91418	CAPACITOR, Ceramic, 0.1 μF +80% -20%, 100 V
	A2C26	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C27	PM10000-1	5GA-T10	56289	CAPACITOR, Ceramic, 100 pF ±20%, 1000 V
	A2C28	PM10007-7	75F3R2A104	03494	CAPACITOR, Mylar, 0.1 μF ±10%, 200 V
	A2C29	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C30	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C31	PM10000-1	5GA-T10	56289	CAPACITOR, Ceramic, 100 pF ±20%, 1000 V
	A2C32	PM10787-5	196D105X0035HA1	56289	CAPACITOR, Tantalum, 1 μF ±20%, 15 V
	A2C33	PM10007-5	75F1R2A223	03494	CAPACITOR, Mylar, .022 μF ±10%, 200 V
	A2C34	PM10001-6	10TCC-Q47	56289	CAPACITOR, Ceramic, 47 pF ±5%, 1000 V
	A2C35	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C36				Not used
	A2C37	PM10787-2	196D126X9020JA1	56289	CAPACITOR, Tantalum, 12 μF ±20%, 15 V
	A2C38	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C39	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C40				Not used
	A2C41	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C42	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C43	PM10000-6	5GA-D47	56289	CAPACITOR, Ceramic, .0047 μF ±20%, 500 V
	A2C44	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C45	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C46	PM10000-6	5GA-D47	56289	CAPACITOR, Ceramic, .0047 μF ±20%, 500 V
	A2C47				CAPACITOR, Value selected at test
	A2C48	PM10003-6	B41010-220/40/8212	25088	CAPACITOR, Electrolytic, 220 μF, 35 VDC
	A2C49	PM10003-6	B41010-220/40/8212	25088	CAPACITOR, Electrolytic, 220 μF, 35 VDC
	A2C50	PM10003-7	B41010-1000/40/8212	25088	CAPACITOR, Electrolytic, 1000 μF, 35 VDC
	A2C51				Not used
	A2C52	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C53	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A2C54	PM10787-3	196D276X9025LA3	56289	CAPACITOR, Tantalum, 27 μF ±20%, 15 V
	A2C55	PM10000-7	5GA-S10	56289	CAPACITOR, Ceramic, .01 μF ±20%, 500 V
	A2C56	PM10787-10	196D107X0020MA3	56289	CAPACITOR, Tantalum, 100 μF ±20%, 20 V
	A2C57	PM10000-7	5GA-S10	56289	CAPACITOR, Ceramic, .01 μF ±20%, 500 V
	A2C58	PM10000-7	5GA-S10	56289	CAPACITOR, Ceramic, .01 μF ±20%, 500 V
	A2C59	PM10787-10	196D107X0020MA3	56289	CAPACITOR, Tantalum, 100 μF ±20%, 20 V
	A2C60	PM10787-10	196D107X0020MA3	56289	CAPACITOR, Tantalum, 100 μF ±20%, 20 V
	A2CR1	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148 (or 1N914)
	A2CR2	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148 (or 1N914)
	A2CR3	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148 (or 1N914)
	A2CR4	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148 (or 1N914)
	A2CR5	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148 (or 1N914)

FIG. NO.	REFERENCE DESIGNATION	SYSTRON-DONNER PART NUMBER	MFR'S PART NUMBER	MFR.	DESCRIPTION
8-2	A2CR6	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148 (or 1N914)
	A2CR7	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148 (or 1N914)
	A2CR8	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148 (or 1N914)
	A2CR9	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148 (or 1N914)
	A2CR10				Not used
	A2CR11				Not used
	A2CR12	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148 (or 1N914)
	A2CR13	PM10044-1	1N4383	12060	DIODE, Silicon, 1N4383
	A2CR14	PM10044-1	1N4383	12060	DIODE, Silicon, 1N4383
	A2CR15	PM10044-1	1N4383	12060	DIODE, Silicon, 1N4383
	A2CR16	PM10044-1	1N4383	12060	DIODE, Silicon, 1N4383
	A2CR17				Not used
	A2CR18				Not used
	A2CR19				Not used
	A2CR20				Not used
	A2CR21	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148 (or 1N914)
	A2CR22	PM10044-1	1N4383	12060	DIODE, Silicon, 1N4383
	A2CR23	PM10044-1	1N4383	12060	DIODE, Silicon, 1N4383
	A2J1	PM10140-2	105-0850-007	74970	TEST JACK, Yellow
	A2J2	PM10140-2	105-0850-007	74970	TEST JACK, Yellow
	A2J3	PM10140-3	105-0850-003	74970	TEST JACK, Black
	A2J4	PM10140-2	105-0850-007	74970	TEST JACK, Yellow
	A2J5	PM10140-2	105-0850-007	74970	TEST JACK, Yellow
	A2J6	PM10140-2	105-0850-007	74970	TEST JACK, Yellow
	A2J7	PM10140-2	105-0850-007	74970	TEST JACK, Yellow
	A2J8	PM10140-4	105-0850-010	74970	TEST JACK, Blue
	A2Q1	PM11432	FM3955	27014	TRANSISTOR, Field Effect, Dual, 2N3955
	A2Q2	PM10018	2N3646	07263	TRANSISTOR, NPN Silicon, 2N3646
	A2Q3	PM10023	2N3644	07263	TRANSISTOR, PNP Silicon, 2N3644
	A2Q4	PM10023	2N3644	07263	TRANSISTOR, PNP Silicon, 2N3644
	A2Q5	PM11457		01220	TRANSISTOR, NPN Silicon, 2N3646 (selected)
	A2Q6	PM10019	2N3565	07263	TRANSISTOR, NPN Silicon, 2N3565
	A2Q7	PM11119	2N4250	07263	TRANSISTOR, PNP Silicon, 2N4250
	A2Q8	PM11119	2N4250	07263	TRANSISTOR, PNP Silicon, 2N4250
	A2Q9	PM10019	2N3565	07263	TRANSISTOR, NPN Silicon, 2N3565
	A2Q10	PM10019	2N3565	07263	TRANSISTOR, NPN Silicon, 2N3565
	A2Q11	PM10019	2N3565	07263	TRANSISTOR, NPN Silicon, 2N3565
	A2Q12	PM10207	SU2080	15818	TRANSISTOR, Field Effect, Dual, 2N3922
	A2Q13	PM10019	2N3565	07263	TRANSISTOR, NPN Silicon, 2N3565
	A2Q14	PM10681	PM10681	01220	TRANSISTOR, NPN Silicon, 2N3563 (selected)
	A2Q15	PM10681	PM10681	01220	TRANSISTOR, NPN Silicon, 2N3563 (selected)
	A2Q16	PM10398	PN4917	07263	TRANSISTOR, PNP Silicon, 2N4121
	A2Q17	PM10398	PN4917	07263	TRANSISTOR, PNP Silicon, 2N4121
	A2Q18	PM10896	3N138	18714	TRANSISTOR, MOSFET, 3N138
	A2Q19	PM10896	3N138	18714	TRANSISTOR, MOSFET, 3N138
	A2Q20	PM10339	2N4360	07263	TRANSISTOR, Field Effect, 2N4360
	A2Q21	PM10017	2N3569	07263	TRANSISTOR, NPN Silicon, 2N3569
	A2Q22	PM11119	2N4250	07263	TRANSISTOR, PNP Silicon, 2N4250
	A2Q23	PM10206	2N3053	07263	TRANSISTOR, NPN Silicon, 2N3053
	A2Q24	PM10017	2N3569	07263	TRANSISTOR, NPN Silicon, 2N3569
	A2Q25				Not used
	A2Q26	PM11303	40389	18714	TRANSISTOR, NPN Silicon, 40389
	A2Q27	PM11507	TIS97	01295	TRANSISTOR, NPN Silicon, TIS97
	A2Q28	PM11507	TIS97	01295	TRANSISTOR, NPN Silicon, TIS97
	A2Q29	PM11119	2N4250	07263	TRANSISTOR, PNP Silicon, 2N4250
	A2Q30	PM11119	2N4250	07263	TRANSISTOR, PNP Silicon, 2N4250
	A2Q31	PM11304	40391	18714	TRANSISTOR, PNP Silicon, 40391
	A2Q32	PM11303	40389	18714	TRANSISTOR, NPN Silicon, 40389
	A2Q33	PM11507	TIS97	01295	TRANSISTOR, NPN Silicon, TIS97
	A2Q34	PM10018	2N3646	07263	TRANSISTOR, NPN Silicon, 2N3646
	A2R1	PM10013-57	B803104NB474	99392	RESISTOR, Carbon, 470 kΩ ±5%, 1/4 W
	A2R2	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R3	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R4	PM10015-25	RN55D6192F	14674	RESISTOR, Metal Film, 61.9 kΩ ±1%, 1/8 W
	A2R5	PM10015-25	RN55D6192F	14674	RESISTOR, Metal Film, 61.9 kΩ ±1%, 1/8 W
	A2R6	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R7	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R8	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R9	PM10046-8	X201R103B	71450	RESISTOR, Variable, 10 kΩ (-20 dBm Cal)

FIG. NO.	REFERENCE DESIGNATION	SYSTRON-DONNER PART NUMBER	MFR'S PART NUMBER	MFR.	DESCRIPTION
8-2	A2R10	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R11	PM10013-37	B803104NB103	99392	RESISTOR, Carbon, 10 kΩ ±5%, 1/4 W
	A2R12	PM11711-2	66WR100K	21030	RESISTOR, Variable, 100 kΩ, 20-turn (0 dBm Cal)
	A2R13	PM10015-34	RN55D1623F	14674	RESISTOR, Metal Film, 162 kΩ ±1%, 1/8 W
	A2R14	PM10015-34	RN55D1623F	14674	RESISTOR, Metal Film, 162 kΩ ±1%, 1/8 W
	A2R15	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R16	PM10015-65	RN55D4991F	14674	RESISTOR, Metal Film, 4990 Ω ±1%, 1/8 W
	A2R17	PM10046-1	X201R501B	71450	RESISTOR, Variable, 500 Ω (+ 10 dBm Cal)
	A2R18	PM10015-170	RN55D3480F	14674	RESISTOR, Metal Film, 348 Ω ± 1%, 1/8 W
	A2R19	PM10015-66	RN55D9531F	14674	RESISTOR, Metal Film, 9530 Ω ±1%, 1/8 W
	A2R20	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R21	PM10013-49	B803104NB104	99392	RESISTOR, Carbon, 100 kΩ ±5%, 1/4 W
	A2R22	PM10013-59	B803104NB684	99392	RESISTOR, Carbon, 680 kΩ ±5%, 1/4 W
	A2R23	PM10013-53	B803104NB224	99392	RESISTOR, Carbon, 220 kΩ ±5%, 1/4 W
	A2R24	PM10013-39	B803104NB153	99392	RESISTOR, Carbon, 15 kΩ ±5%, 1/4 W
	A2R25	PM10013-39	B803104NB153	99392	RESISTOR, Carbon, 15 kΩ ±5%, 1/4 W
	A2R26	PM10013-45	B803104NB473	99392	RESISTOR, Carbon, 47 kΩ ±5%, 1/4 W
	A2R27	PM10013-25	B803104NB102	99392	RESISTOR, Carbon, 1000 Ω ±5%, 1/4 W
	A2R28	PM10013-57	B803104NB474	99392	RESISTOR, Carbon, 470 kΩ ±5%, 1/4 W
	A2R29	PM10013-55	B803104NB334	99392	RESISTOR, Carbon, 330 kΩ ±5%, 1/4 W
	A2R30	PM10013-53	B803104NB224	99392	RESISTOR, Carbon, 220 kΩ ±5%, 1/4 W
	A2R31	PM10013-53	B803104NB224	99392	RESISTOR, Carbon, 220 kΩ ±5%, 1/4 W
	A2R32	PM10013-49	B803104NB104	99392	RESISTOR, Carbon, 100 kΩ ±5%, 1/4 W
	A2R33	PM10013-45	B803104NB473	99392	RESISTOR, Carbon, 47 kΩ ±5%, 1/4 W
	A2R34	PM10013-43	B803104NB333	99392	RESISTOR, Carbon, 33 kΩ ±5%, 1/4 W
	A2R35	PM10013-53	B803104NB224	99392	RESISTOR, Carbon, 220 kΩ ±5%, 1/4 W
	A2R36	PM10013-25	B803104NB102	99392	RESISTOR, Carbon, 1000 Ω ±5%, 1/4 W
	A2R37	PM10013-37	B803104NB103	99392	RESISTOR, Carbon, 10 kΩ ±5%, 1/4 W
	A2R38	PM10013-61	B803104NB105	99392	RESISTOR, Carbon, 1 MΩ ±5%, 1/4 W
	A2R39	PM10013-73	B803104NB106	99392	RESISTOR, Carbon 10 MΩ ±5%, 1/4 W
	A2R40	PM10013-37	B803104NB103	99392	RESISTOR, Carbon, 10 kΩ ±5%, 1/4 W
	A2R41	PM10015-36	RM55D5111F	14674 01220	RESISTOR, Metal Film, 5110 Ω ±1%, 1/8 W or Value Determined at Test for some units
	A2R42	PM10015-7	RN55D1002F	14674	RESISTOR, Metal Film, 10 kΩ ±1%, 1/8 W
	A2R43	PM10013-33	B803104NB472	99392	RESISTOR, Carbon, 4700 Ω ±5%, 1/4 W
	A2R44	PM10013-11	B803104NB680	99392	RESISTOR, Carbon, 68 Ω ±5%, 1/4 W
	A2R45	PM10015-7	RN55D1002F	14674	RESISTOR, Metal Film, 10 kΩ ±1%, 1/8 W
	A2R46	PM10013-9	B803104NB470	99392	RESISTOR, Carbon, 47 Ω ±5%, 1/4 W
	A2R47	PM10013-9	B803104NB470	99392	RESISTOR, Carbon, 47 Ω ±5%, 1/4 W
	A2R48	PM10013-37	B803104NB103	99392	RESISTOR, Carbon, 10 kΩ ±5%, 1/4 W
	A2R49	PM10013-37	B803104NB103	99392	RESISTOR, Carbon, 10 kΩ ±5%, 1/4 W
	A2R50	PM10013-1	B803104NB100	99392	RESISTOR, Carbon, 10 Ω ±5%, 1/4 W
	A2R51	PM10013-35	B803104NB682	99392	RESISTOR, Carbon, 6800 Ω ±5%, 1/4 W
	A2R52	PM10013-39	B803104NB153	99392	RESISTOR, Carbon, 15 kΩ ±5%, 1/4 W
	A2R53	PM10013-29	B803104NB222	99392	RESISTOR, Carbon, 2200 Ω ±5%, 1/4 W
	A2R54	PM10013-33	B803104NB472	99392	RESISTOR, Carbon, 4700 Ω ±5%, 1/4 W
	A2R55	PM10013-9	B803104NB470	99392	RESISTOR, Carbon, 47 Ω ±5%, 1/4 W
	A2R56	PM10013-9	B803104NB470	99392	RESISTOR, Carbon, 47 Ω ±5%, 1/4 W
	A2R57	PM10013-33	B803104NB472	99392	RESISTOR, Carbon, 4700 Ω ±5%, 1/4 W
	A2R58	PM10013-1	B803104NB100	99392	RESISTOR, Carbon, 10 Ω ±5%, 1/4 W
	A2R59	PM10013-17	B803104NB221	99392	RESISTOR, Carbon, 220 Ω ±5%, 1/4 W
	A2R60	PM10013-9	B803104NB470	99392	RESISTOR, Carbon, 47 Ω ±5%, 1/4 W
	A2R61	PM10013-35	B803104NB682	99392	RESISTOR, Carbon, 6800 Ω ±5%, 1/4 W
	A2R62	PM10013-33	B803104NB472	99392	RESISTOR, Carbon, 4700 Ω ±5%, 1/4 W
	A2R63	PM10046-10	X201R104B	71450	RESISTOR, Variable, 100 kΩ (Zero Cal)
	A2R64	PM10013-73	B803104NB106	99392	RESISTOR, Carbon, 10 MΩ ±5%, 1/4 W
	A2R65	PM10142-4	B803104NB226	99392	RESISTOR, Carbon, 22 MΩ ±5%, 1/4 W
	A2R66	PM10013-49	B803104NB104	99392	RESISTOR, Carbon, 100 kΩ ±5%, 1/4 W
	A2R67	PM10013-49	B803104NB104	99392	RESISTOR, Carbon, 100 kΩ ±5%, 1/4 W
	A2R68	PM10013-73	B803104NB106	99392	RESISTOR, Carbon, 10 MΩ ±5%, 1/4 W
	A2R69	PM10013-49	B803104NB104	99392	RESISTOR, Carbon, 100 kΩ ±5%, 1/4 W
	A2R70	PM10015-122	RN55D11R0F	14674	RESISTOR, Metal Film, 11 Ω ±1%, 1/8 W
	A2R71	PM10013-57	B803104NB474	99392	RESISTOR, Carbon, 470 kΩ ±5%, 1/4 W
	A2R72	PM10046-10	X201R104B	71450	RESISTOR, Variable, 100 k Ω (Input Zero)
	A2R73	PM10013-29	B803104NB222	99392	RESISTOR, Carbon, 2200 Ω ±5%, 1/4 W
	A2R74	PM10013-33	B803104NB472	99392	RESISTOR, Carbon, 4700 Ω ±5%, 1/4 W
	A2R75	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R76	PM10013-27	B803104NB152	99392	RESISTOR, Carbon, 1500 Ω ±5%, 1/4 W
	A2R77	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R78	PM10013-69	B803104NB475	99392	RESISTOR, Carbon, 4.7 MΩ ±5%, 1/4 W
	A2R79	PM10013-19	B803104NB331	99392	RESISTOR, Carbon, 330 Ω ±5%, 1/4 W

FIG. NO.	REFERENCE DESIGNATION	SYSTRON-DONNER PART NUMBER	MFR'S PART NUMBER	MFR.	DESCRIPTION
8-2	A2R150	PM10013-25	B803104NB102	99392	RESISTOR, Carbon, 1000 Ω ±5%, 1/4 W
	A2R151	PM11485-11	RN60J2501B	14674	RESISTOR, Metal Film, 2500 Ω ±0.1%, 1/4 W
	A2R152	PM11485-11	RN60J2501B	14674	RESISTOR, Metal Film, 2500 Ω ±0.1%, 1/4 W
	A2R153	PM10015-50	RN55D1471F	14674	RESISTOR, Metal Film, 1470 Ω ±1%, 1/8 W
	A2R154	PM10046-6	X201R201B	71450	RESISTOR, Variable, 200 Ω (-12.6 V Adjust)
	A2R155	PM10015-50	RN55D1471F	14674	RESISTOR, Metal Film, 1470 Ω ±1%, 1/8 W
	A2RT1	PM10209	51RD262	09052	THERMISTOR, 100 kΩ (cold)
	A2S1	PM11680	4XF20-2U-GR	05464	SWITCH ASSEMBLY, Pushbutton
	A2U1	PM11539	μA 741HC	07263	INTEGRATED CIRCUIT, Operational Amplifier, 741
	A2U2	PM11539	μA 741HC	07263	INTEGRATED CIRCUIT, Operational Amplifier, 741
	A2U3	PM10769	μA 709HC	07263	INTEGRATED CIRCUIT, Operational Amplifier, 709
	A2U4	PM11539	μA 741HC	07263	INTEGRATED CIRCUIT, Operational Amplifier, 741
	A2U5	PM11539	μA 741HC	07263	INTEGRATED CIRCUIT, Operational Amplifier, 741
	A2U6	PM11539	μA 741HC	07263	INTEGRATED CIRCUIT, Operational Amplifier, 741
	A2U7	PM11332	CA3054	18714	INTEGRATED CIRCUIT, Transistor Array, CA3054
	A2VR1	PM10045	1N823	12065	DIODE, Reference, 6.2 V, 1N823
		PM10694		01220	BLOCK, Oven
		PM10716		01220	COVER, Oven Block
		PM10600	60599-1	04618	PIN, Connector
		PM10978-1	583527-1	04618	SOCKET, Dual In-line, 14-pin
		PM11765		01220	BOARD, Printed Circuit

FIG. NO.	REFERENCE DESIGNATION	SYSTRON-DONNER PART NUMBER	MFR'S PART NUMBER	MFR.	DESCRIPTION
8-2	A2R80	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R81	PM10013-69	B803104NB475	99392	RESISTOR, Carbon, 4.7 MΩ ±5%, 1/4 W
	A2R82	PM10013-17	B803104N201	99392	RESISTOR, Carbon, 200 Ω ±5%, 1/4 W
	A2R83	PM10013-37	B803104NB103	99392	RESISTOR, Carbon, 10 kΩ ±5%, 1/4 W
	A2R84	PM10013-57	B803104NB474	99392	RESISTOR, Carbon, 470 kΩ ±5%, 1/4 W
	A2R85	PM10013-33	B803104NB472	99392	RESISTOR, Carbon, 4700 Ω ±5%, 1/4 W
	A2R86				Not used
	A2R87	PM10013-29	B803104NB222	99392	RESISTOR, Carbon, 2200 Ω ±5%, 1/4 W
	A2R88	PM10013-25	B803104NB102	99392	RESISTOR, Carbon, 1000 Ω ±5%, 1/4 W
	A2R89	PM10013-31	B803104NB332	99392	RESISTOR, Carbon, 3300 Ω ±5%, 1/4 W
	A2R90	PM10013-25	B803104NB102	99392	RESISTOR, Carbon, 1000 Ω ±5%, 1/4 W
	A2R91	PM10015-28	RN55D2372F	14674	RESISTOR, Metal Film, 23.7 kΩ ±1%, 1/8 W
	A2R92	PM10013-5	B803104NB220	99392	RESISTOR, Carbon, 22 Ω ±5%, 1/4 W
	A2R93	PM10015-6	RN55D4643F	14674	RESISTOR, Metal Film, 464 kΩ ±1%, 1/8 W
	A2R94	PM10015-26	RN55D1543F	14674	RESISTOR, Metal Film, 154 kΩ ±1%, 1/8 W
	A2R95	PM10046-2	X201R203B	71450	RESISTOR, Variable, 20 kΩ (75 Ω Cal)
	A2R96	PM10013-53	B803104NB224	99392	RESISTOR, Carbon, 220 kΩ ±5%, 1/4 W
	A2R97	PM10046-10	X201R104B	71450	RESISTOR, Variable, 100 kΩ (dBm Offset)
	A2R98	PM10013-53	B803104NB224	99392	RESISTOR, Carbon, 220 kΩ ±5%, 1/4 W
	A2R99	PM10015-19	RN55D1001F	14674	RESISTOR, Metal Film, 1000 Ω ±1%, 1/8 W
	A2R100	PM10015-87	RN55D1502F	14674	RESISTOR, Metal Film, 15 kΩ ±1%, 1/8 W
	A2R101	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R102	PM10015-19	RN55D1001F	14674	RESISTOR, Metal Film, 1000 Ω ±1%, 1/8 W
	A2R103	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R104	PM10015-87	RN55D1502F	14674	RESISTOR, Metal Film, 15 kΩ ±1%, 1/8 W
	A2R105	PM10015-66	RN55D9531F	14674	RESISTOR, Metal Film, 9530 Ω ±1%, 1/8 W
	A2R106	PM10046-7	X201R102B	71450	RESISTOR, Variable, 1000 Ω (X1 Gain)
	A2R107	PM10013-33	B803104NB472	99392	RESISTOR, Carbon, 4700 Ω ±5%, 1/4 W
	A2R108	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R109	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R110	PM10013-17	B803104NB221	99392	RESISTOR, Carbon, 220 Ω ±5%, 1/4 W
	A2R111				Not used
	A2R112				Not used
	A2R113				Not used
	A2R114	PM10015-7	RN55D1002F	14674	RESISTOR, Metal Film, 10 kΩ ±1%, 1/8 W
	A2R115	PM10015-90	RN55D2492F	14674	RESISTOR, Metal Film, 24.9 kΩ ±1%, 1/8 W
	A2R116	PM10015-187	RN55D8872F	14674	RESISTOR, Metal Film, 88.7 kΩ ±1%, 1/8 W
	A2R117	PM10046-4	X201R502B	71450	RESISTOR, Variable, 5000 Ω (X10 Gain)
	A2R118				Not used
	A2R119				Not used
	A2R120				Not used
	A2R121	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R122	PM10015-66	RN55D9531F	14674	RESISTOR, Metal Film, 9530 Ω ±1%, 1/8 W
	A2R123	PM10046-7	X201R102B	71450	RESISTOR, Variable, 1000 Ω (dBm Gain)
	A2R124	PM10013-33	B803104NB472	99392	RESISTOR, Carbon, 4700 Ω ±5%, 1/4 W
	A2R125	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R126	PM10013-17	B803104NB221	99392	RESISTOR, Carbon, 220 Ω ±5%, 1/4 W
	A2R127	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R128	PM10015-7	RN55D10C2F	14674	RESISTOR, Metal Film, 10 kΩ ±1%, 1/8 W
	A2R129	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A2R130	PM10013-15	B803104NB151	99392	RESISTOR, Carbon, 150 Ω ±5%, 1/4 W
	A2R131	PM10013-1	B803104NB100	99392	RESISTOR, Carbon, 10 Ω ±5%, 1/4 W
	A2R132	PM10015-87	RN55D1502F	14674	RESISTOR, Metal Film, 15 kΩ ±1%, 1/8 W
	A2R133				Not used
	A2R134	PM10013-15	B803104NB151	99392	RESISTOR, Carbon, 150 Ω ±5%, 1/4 W
	A2R135	PM10013-41	B803104NB223	99392	RESISTOR, Carbon, 22 kΩ ±5%, 1/4 W
	A2R136	PM10013-41	B803104NB223	99392	RESISTOR, Carbon, 22 kΩ ±5%, 1/4 W
	A2R137	PM10013-15	B803104NB151	99392	RESISTOR, Carbon, 150 Ω ±5%, 1/4 W
	A2R138				Not used
	A2R139				Not used
	A2R140	PM10013-25	B803104NB102	99392	RESISTOR, Carbon, 1000 Ω ±5%, 1/4 W
	A2R141	PM10015-19	RN55D1001F	14674	RESISTOR, Metal Film, 1000 Ω ±1%, 1/8 W
	A2R142	PM10015-11	RN55D3011F	14674	RESISTOR, Metal Film, 3010 Ω ±1%, 1/8 W
	A2R143	PM10013-37	B803104NB103	99392	RESISTOR, Carbon, 10 kΩ ±5%, 1/4 W
	A2R144	PM10013-37	B803104NB103	99392	RESISTOR, Carbon, 10 kΩ ±5%, 1/4 W
	A2R145	PM10013-23	B803104NB681	99392	RESISTOR, Carbon, 680 Ω ±5%, 1/4 W
	A2R146	PM10013-23	B803104NB681	99392	RESISTOR, Carbon, 680 Ω ±5%, 1/4 W
	A2R147	PM10013-27	B803104NB152	99392	RESISTOR, Carbon, 1500 Ω ±5%, 1/4 W
	A3R148	PM10013-27	B803104NB152	99392	RESISTOR, Carbon, 1500 Ω ±5%, 1/4 W
	A2R149	PM10013-29	B803104NB222	99392	RESISTOR, Carbon, 2200 Ω ±5%, 1/4 W

FIG. NO.	REFERENCE DESIGNATION	SYSTRON-DONNER PART NUMBER	MFR'S PART NUMBER	MFR.	DESCRIPTION
8-3	A3	PM11686		01220	BOARD ASSY - CALIBRATOR Consisting of:
	A3C1	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	A3C2	PM10007-7	75F3R2A104	03494	CAPACITOR, Mylar, 0.1 μF ±10%, 200 V
	A3C3	PM10000-1	5GA-T10	56289	CAPACITOR, Ceramic, 100 pF ±20%, 1000 V
	A3C4	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 1000 V
	A3C5	PM10000-1	5GA-T10	56289	CAPACITOR, Ceramic, 100 pF ±20%, 1000 V
	A3C6	PM10000-4	5GA-T10	56289	CAPACITOR, Ceramic, .001 μF ±20%, 1000 V
	A3C7	PM10001-9	10TCC-V68	56289	CAPACITOR, Ceramic, 6.8 pF ±5%, 1000 V
	A3C8	PM10000-1	5GA-T10	56289	CAPACITOR, Ceramic, 100 pF ±20%, 1000 V
	A3C9	PM10000-12	5GA-T15	56289	CAPACITOR, Ceramic, 150 pF ±20%, 1000 V
	A3C10	PM10000-3	5GA-T47	56289	CAPACITOR, Ceramic, 470 pF ±20%, 1000 V
	A3C11	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 1000 V
	A3C12				CAPACITOR, Value selected at test
	A3C13	PM10001-7	10TCC-T10	56289	CAPACITOR, Ceramic, 100 pF ±5%, 1000 V
	A3C14	PM10001-15	10TCC-T15	56289	CAPACITOR, Ceramic, 150 pF ±5%, 1000 V
	A3C15	PM10001-5	10TCC-Q33	56289	CAPACITOR, Ceramic, 33 pF ±5%, 1000 V
	A3C16				CAPACITOR, Value selected at test
	A3C17	PM10001-7	10TCC-T10	56289	CAPACITOR, Ceramic, 100 pF ±5%, 1000 V
	A3CR1	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148
	A3CR2	PM10043-2	1N4148	03494	DIODE, Silicon, 1N4148
	A3CR3	PM11345	5082-2900	28480	DIODE, Silicon, HPA 2900
	A3CR4	PM11345	5082-2900	28480	DIODE, Silicon, HPA 2900
	A3L1	PM10631-3	1025-12	99800	INDUCTOR, RF, 0.47 μH ±10%
	A3L2	PM10631-11	1025-08	99800	INDUCTOR, RF, 0.33 μH ±10%
	A3L3	PM10631-11	1025-08	99800	INDUCTOR, RF, 0.33 μH ±10%
	A3Q1	PM11507	TIS97	01295	TRANSISTOR, NPN Silicon, TIS97
	A3Q2	PM11507	TIS97	01295	TRANSISTOR, NPN Silicon, TIS97
	A3Q3	PM10398	PN4917	07263	TRANSISTOR, PNP Silicon, 2N4121
	A3R1	PM10015-58	RN55D9760F	14674	RESISTOR, Metal Film, 9760 Ω ±1%, 1/8 W
	A3R2	PM10046-7	X201R102B	71450	RESISTOR, Variable, 1000 Ω (10 mW Adjust)
	A3R3	PM10015-105	RN55D6191F	14674	RESISTOR, Metal Film, 6190 Ω ±1%, 1/8 W
	A3R4	PM10013-1	B803104NB100	99392	RESISTOR, Carbon, 10 Ω ±5%, 1/4 W
	A3R5	PM10013-29	B803104NB222	99392	RESISTOR, Carbon, 2200 Ω ±5%, 1/4 W
	A3R6	PM10013-29	B803104NB222	99392	RESISTOR, Carbon, 2200 Ω ±5%, 1/4 W
	A3R7	PM10013-37	B803104NB103	99392	RESISTOR, Carbon, 10 kΩ ±5%, 1/4 W
	A3R8	PM10013-1	B803104NB100	99392	RESISTOR, Carbon, 10 Ω ±5%, 1/4 W
	A3R9	PM10013-17	B803104NB221	99392	RESISTOR, Carbon, 220 Ω ±5%, 1/4 W
	A3R10	PM10013-13	B803104NB101	99392	RESISTOR, Carbon, 100 Ω ±5%, 1/4 W
	A3R11	PM10015-3	RN55D49R9F	14674	RESISTOR, Metal Film, 49.9 Ω ±1%, 1/8 W
	A3R12	PM11485-7	RN601J2210B	14674	RESISTOR, Metal Film, 221 Ω ±0.1%, 1/4 W
	A3R13	PM11485-2	RN601J23R8B	14674	RESISTOR, Metal Film, 23.8 Ω ±0.1%, 1/4 W
	A3R14	PM11485-7	RN601J2210B	14674	RESISTOR, Metal Film, 221 Ω ±0.1%, 1/4 W
		PM10600	60599-1	04618	PIN, Connector
		PM11685		01220	BOARD, Printed Circuit

FIG. NO.	REFERENCE DESIGNATION	SYSTRON-DONNER PART NUMBER	MFR'S PART NUMBER	MFR.	DESCRIPTION
8-1	A4	PM11611		01220	PROBE ASSY - POWER HEAD, 4020A Consisting of:
		PM12220		01220	CRYSTAL DETECTOR KIT - 12.4 GHZ Contains:
	A4CR1	PM10969 }		01220	DETECTOR, Crystal, 12.4 GHz
		PM10969 }		01220	SPACER, Capsule, matched to crystal
		PM11617		01220	LABEL, Calibration
		PM12219		01220	WASHER, Capacitive
8-2	A2R41			01220	RESISTOR, Value Selected at Test
8-1		PM12216-1		01220	CONNECTOR ASSY Contains:
				01220	Precision Type N Male Connector
				01220	Attenuator, 3 dB, 50 Ω
		PM11609		01220	PROBE BODY
		PM12209		01220	WASHER, Thermoplastic
		PM12208		01220	CLAMP, Slotted
8-1	A5	PM12236		01220	PROBE ASSY - POWER HEAD, 4021 Consisting of:
		PM12372		01220	CRYSTAL DETECTOR KIT - 18.0 GHz Contains:
		PM11285 }		01220	DETECTOR, Crystal, 18.0 GHz
		PM11285 }		01220	SPACER, Capsule, matched to crystal
		PM12242		01220	LABEL, Calibration
		PM12219		01220	WASHER, Capacitive
8-2	A2R41			01220	RESISTOR, Value Selected at Test
8-1		- - - - - -		01220	CONNECTOR ASSY Contains:
		108151	131-1054	89709	CONTACT, Center
		PM12370		01220	PROBE BODY Contains:
		PM10781		01220	RESISTOR, Feedthrough, 50 Ω
		PM12369		01220	PIN, Feedthrough
		PM10740		01220	GROMMET, Insulating
		PM11028		01220	LABEL, Warning
8-1	C1	PM10000-11	805-000-X5V0-103Z	72982	CAPACITOR, Ceramic, .01 μF ±20%, 100 V
	DS1	PM11788-1	BFB-14R	34165	LAMP ASSY, Red, 14 V @ 30 mA
	F1	PM10064-2	312-500	75915	FUSE, 3AG, 0.5 A @ 250 V
	J1	PM12355	EAC-301	82389	CONNECTOR, Receptacle, power line
	J2	PM11689	28JR106-6	24931	CONNECTOR, Receptacle, insulated BNC
	J3	PM13242-2	251-15-30-410	71785	CONNECTOR, Receptacle, printed circuit board
	R1	PM10217	7286-5K	21030	RESISTOR, Variable, 5000 Ω, 10-turn (Offset)
	R2	PM11676-1	WA1G012S104MZ	01121	RESISTOR, Variable, 100 kΩ (Zero)
	R3	PM11688-1	274-1-104M	80294	RESISTOR, Variable, 100 kΩ, 25-turn (dBm Cal)
	S1	PM10057	7201	09353	SWITCH, Toggle, DPDT (Power)
	S2	PM11160	SW422GK115/230	30698	SWITCH, Slide, DPDT (115/230 V)
	S3	PM10059	G126	79727	SWITCH, Slide, DPDT (Grounding)
	S4	PM10059	G126	79727	SWITCH, Slide, DPDT (Level)
	T1	PM11857		01220	TRANSFORMER, Power
	W1	PM11805		01220	CABLE/CAP ASSY - POWER HEAD Includes:
		PM13121		01220	CABLE
	W1C1	PM11573-1	G504BX102M*	01220	CAPACITOR, Ceramic, .001 μF ±20%, 50 V
	W1R1	PM10781		01220	RESISTOR, Feedthrough, 50 Ω (includes spring)
	W1R2	PM11518-2	RE1/8C-1*	01220	RESISTOR, Metal Film, 1000 Ω ±1%, 1/8 W
	W1RT1	PM10840	48A12*	01220	THERMISTOR, 75 kΩ ±20% (cold)
	W2	PM12356	17252	16428	CORD SET, Power, 3-wire
					*Modified part

FIG. NO.	REFERENCE DESIGNATION	SYSTRON-DONNER PART NUMBER	MFR'S PART NUMBER	MFR.	DESCRIPTION
8-1	W3	PM11798		01220	CABLE ASSY - CALIBRATOR OUTPUT, 4020A Containing:
		PM11413	82-5377	89709	CONNECTOR, Receptacle, Type N (UG-1095A/U)
		PM11414	8259	16428	CABLE, Coaxial, 50Ω (RG-58A/U)
	W4	PM12197		01220	CABLE ASSY - CALIBRATOR OUTPUT, 4021 Containing:
		PM12138		01220	CONNECTOR, Cable-mount Flange, APC-7
		PM11414	8259	16428	CABLE, Coaxial, 50Ω (RG-58A/U)
	XF1	PM13066	342004	75915	FUSEHOLDER
		PM11789		01220	BUSHING
		H-1927		52542	BAIL AND FOOT ASSY
		PM13333		01220	BRACKET, Connector
		PM11816		01220	COVER, Bottom
		C33565-3		52542	COVER, Side
		D33567-3		52542	COVER, Top
		PM13326		01220	DECK
		PM13329-1		01220	GUSSET, Right
		PM13329-2		01220	GUSSET, Left
		C33570-3		52542	HANDLE, Strap
		240029		52542	HANDLE, Front
		240209		01220	HOLDER, Probe
		PM13327		01220	PANEL, Front, structural
		PM13347-1		01220	PANEL, Front, 4020A overlay
		PM13347-2		01220	PANEL, Front, 4021 overlay
		PM13328		01220	PANEL, Rear
		PM10803-2		01220	KNOB, Black (Offset)
		PM11536		01220	KNOB, Pushbutton
		PM10057-1	A7062-1BLK	09353	KNOB, Switch Cap
		C33674-1		52542	TRIM, End
		C33566		52542	TRIM, Front
		C33564-3		52542	TRIM, Side

SECTION VIII

CIRCUIT DIAGRAMS

This section contains the following diagrams:

Figure	Title	Page
8-1	Digital Power Meter, Interconnect Schematic Diagram	8-2
8-2	Input Amplifier Assembly, Schematic Diagram	8-3
8-3	Calibrator Assembly, Schematic Diagram	8-6

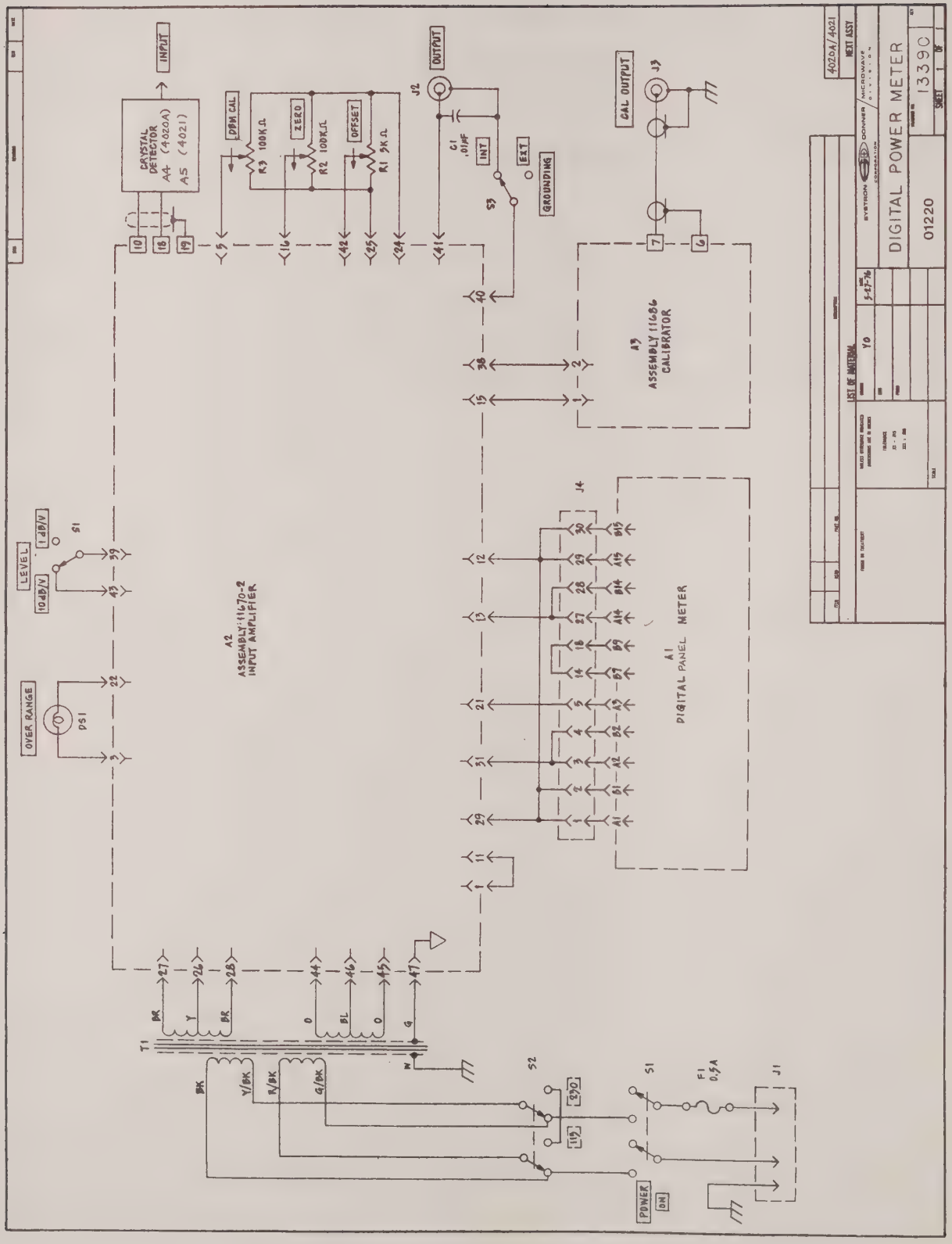


Figure 8-1. Digital Power Meter, Interconnect Schematic Diagram

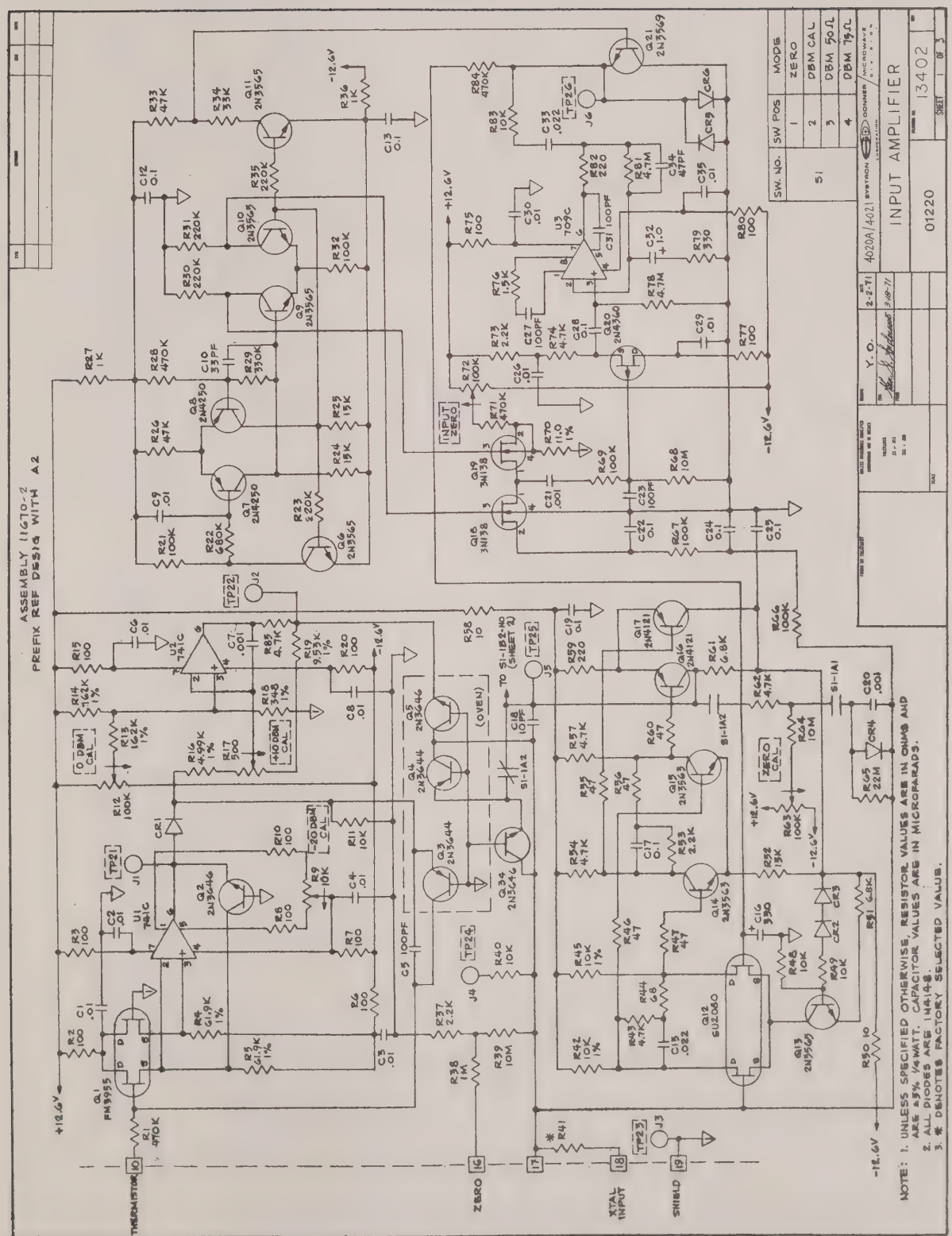


Figure 8-2. Input Amplifier Assembly, Schematic Diagram (Sheet 1 of 3)

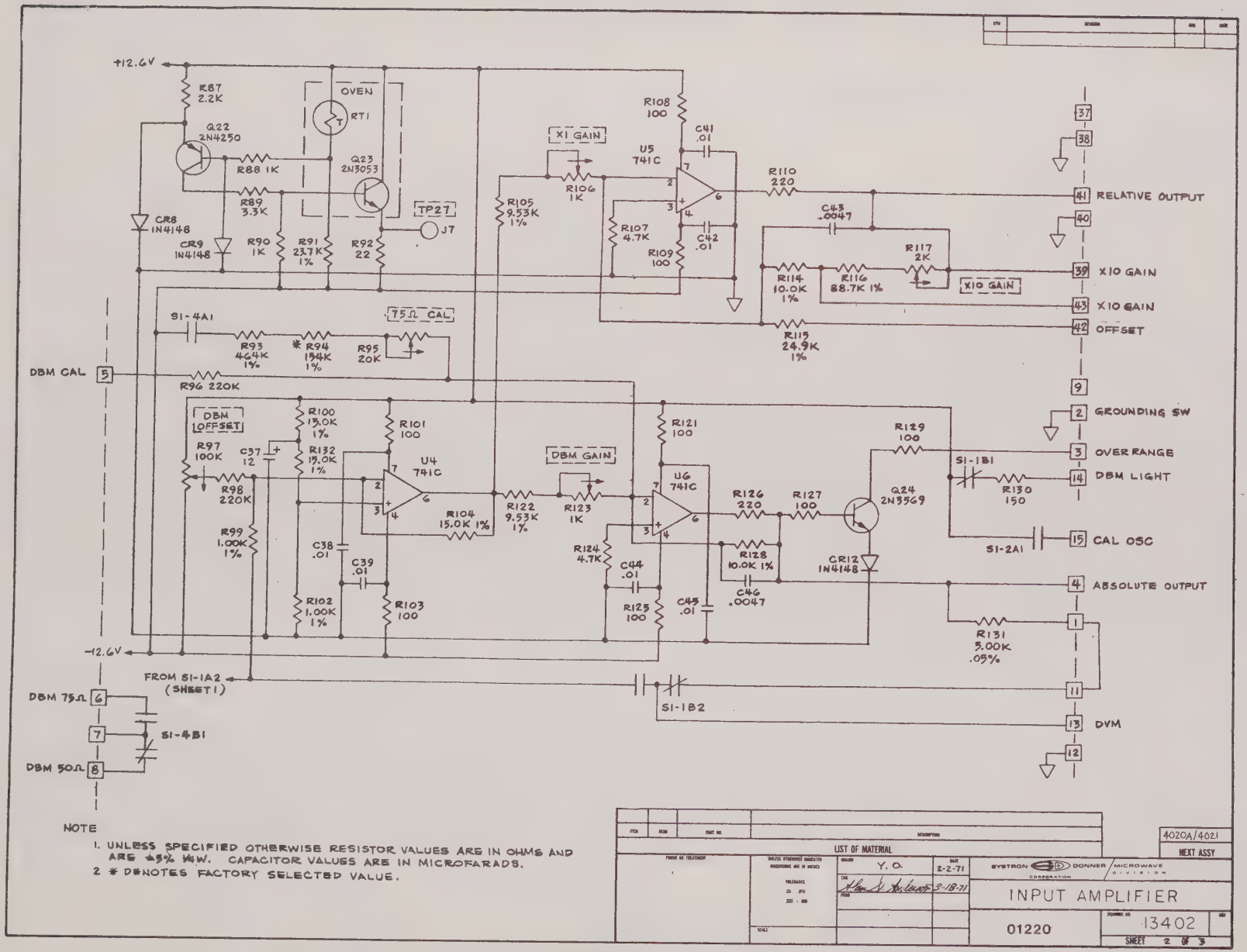


Figure 8-2. Input Amplifier Assembly, Schematic Diagram (Sheet 2 of 3)

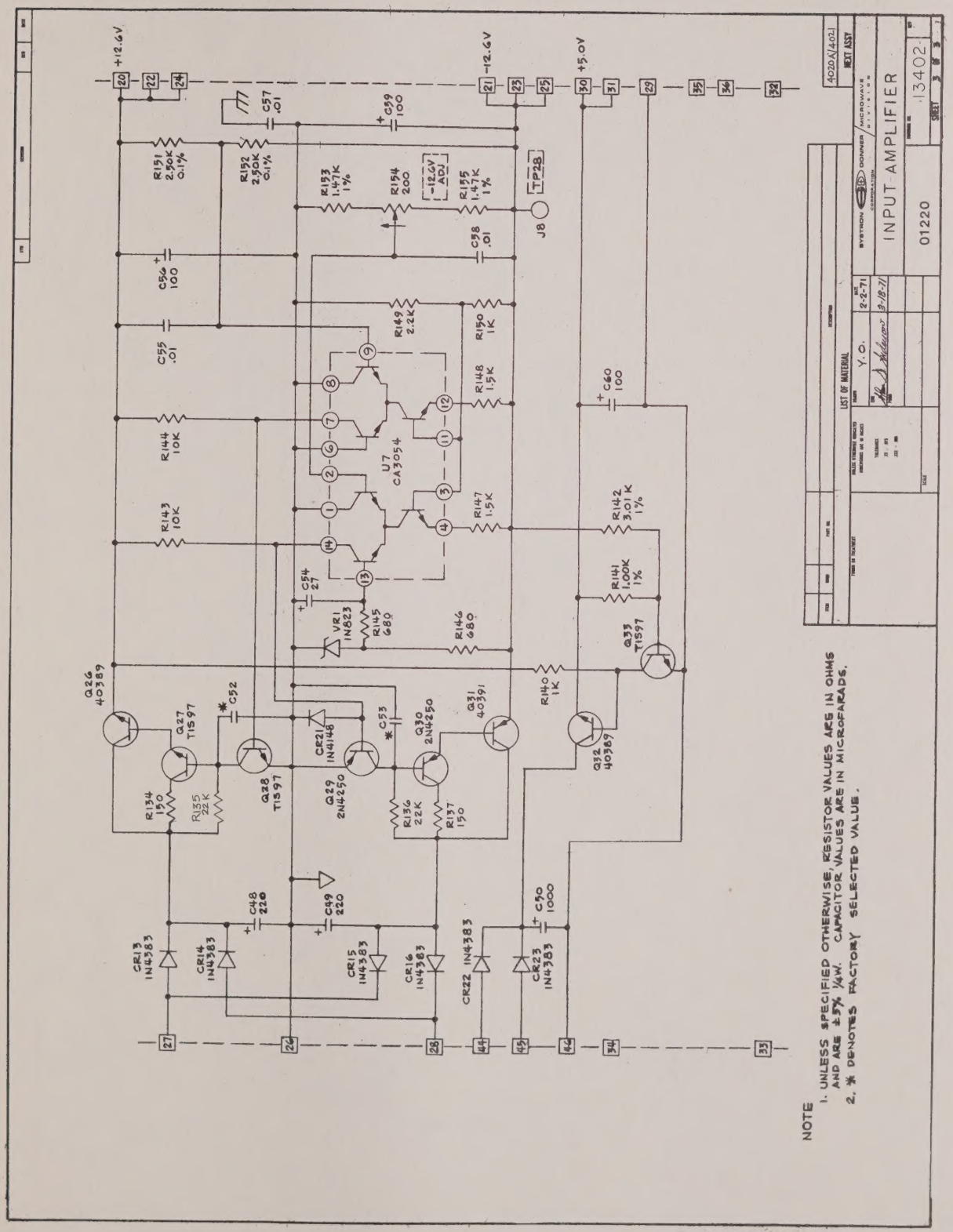


Figure 8-2. Input Amplifier Assembly, Schematic Diagram (Sheet 3 of 3)

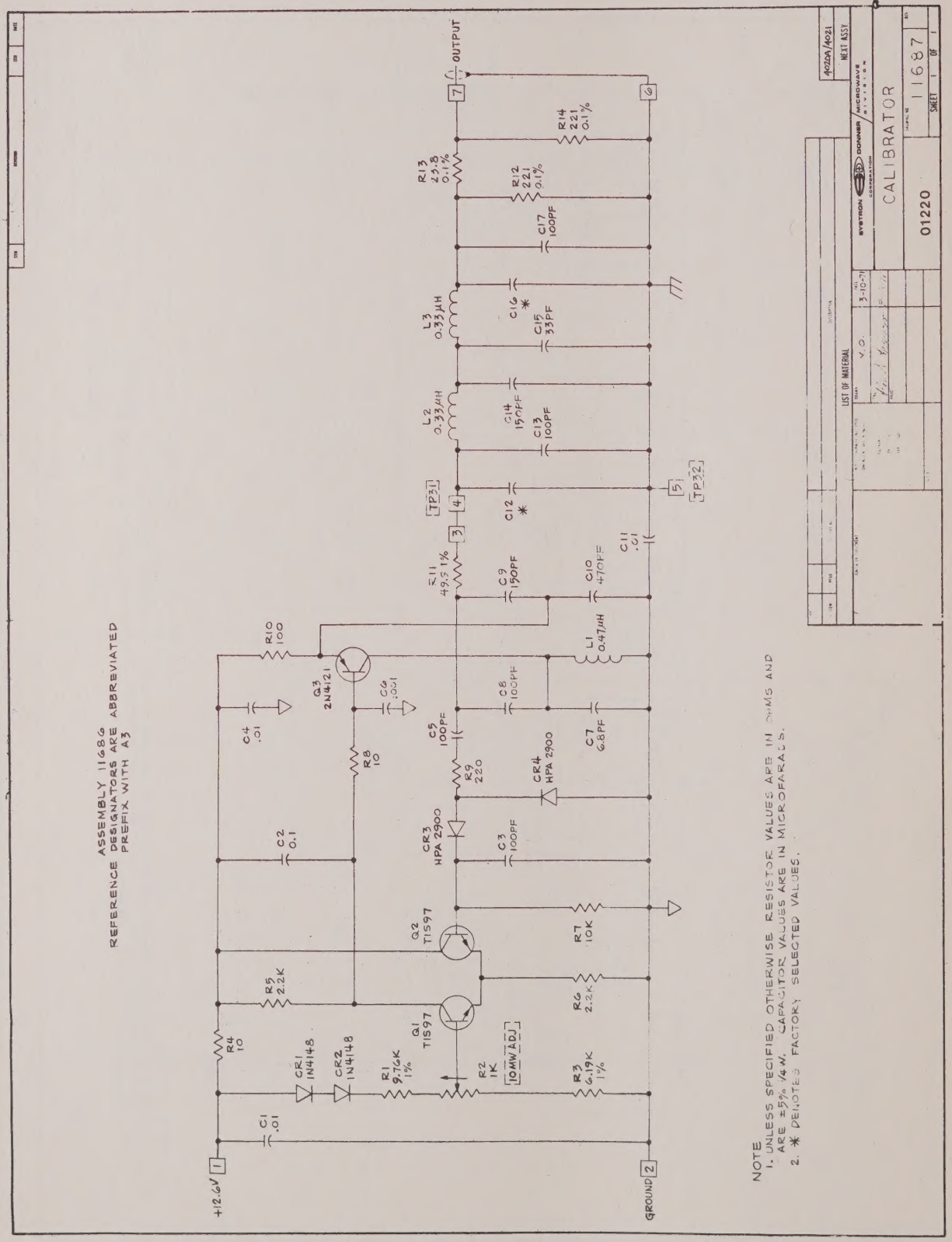


Figure 8-3. Calibrator Assembly, Schematic Diagram

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